Motorship

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ARTICLES on design, construction and operation of oil-engines and motorships by the world's foremost writers on marine engineering.

Motorship

ILLUSTRATIONS of the newest designs in international merchant motorship and Diesel-engine construction and auxiliary equipment.

Vol. XI | July, 1926 | No. 7

Diesel-Electric Ship for Great Lakes

Ms. Steel Electrician to Operate Between Chicago and Montreal for Subsidiary of U. S. Steel Corporation with Steelmotor, Steelvendor, and Steel Chemist

A THIRD motorship has been added to the fleet of the U. S. Steel Products Co. by the commissioning of STEEL ELECTRICIAN, a vessel of 1694 tons gross with Diesel-electric propulsion. Like her prototypes STEELMOTOR and STEELVENDOR, built in 1923, STEEL ELECTRICIAN is intended specifically for the transportation of steel plates and shapes from the U. S. Steel Corporation mills in the Chicago district to Montreal, Canada.

There are independent steel mills much closer to Montreal than the Steel Corporation plants on the lower shores of Lake Michigan, and transhipment can be made at Montreal to vessels sailing for all parts of the world. The operation of these vessels by the U. S. Steel Products Co., which is the export end of the U. S. Steel Corporation, is therefore clearly an important link in the sales of products from the Corporation mills in southern Illinois and northern Indiana.

Limited by the dimensions of the Welland Canal locks through which they pass round Niagara Falls on the Canadian side from Lake Erie to Lake Ontario, these motorvessels of the U. S. Steel Products Co. are not large compared with the large ore-carriers which operate west of Buffalo, but they are of the maximum size possible in the U. S.-Canadian trade on the Great Lakes.

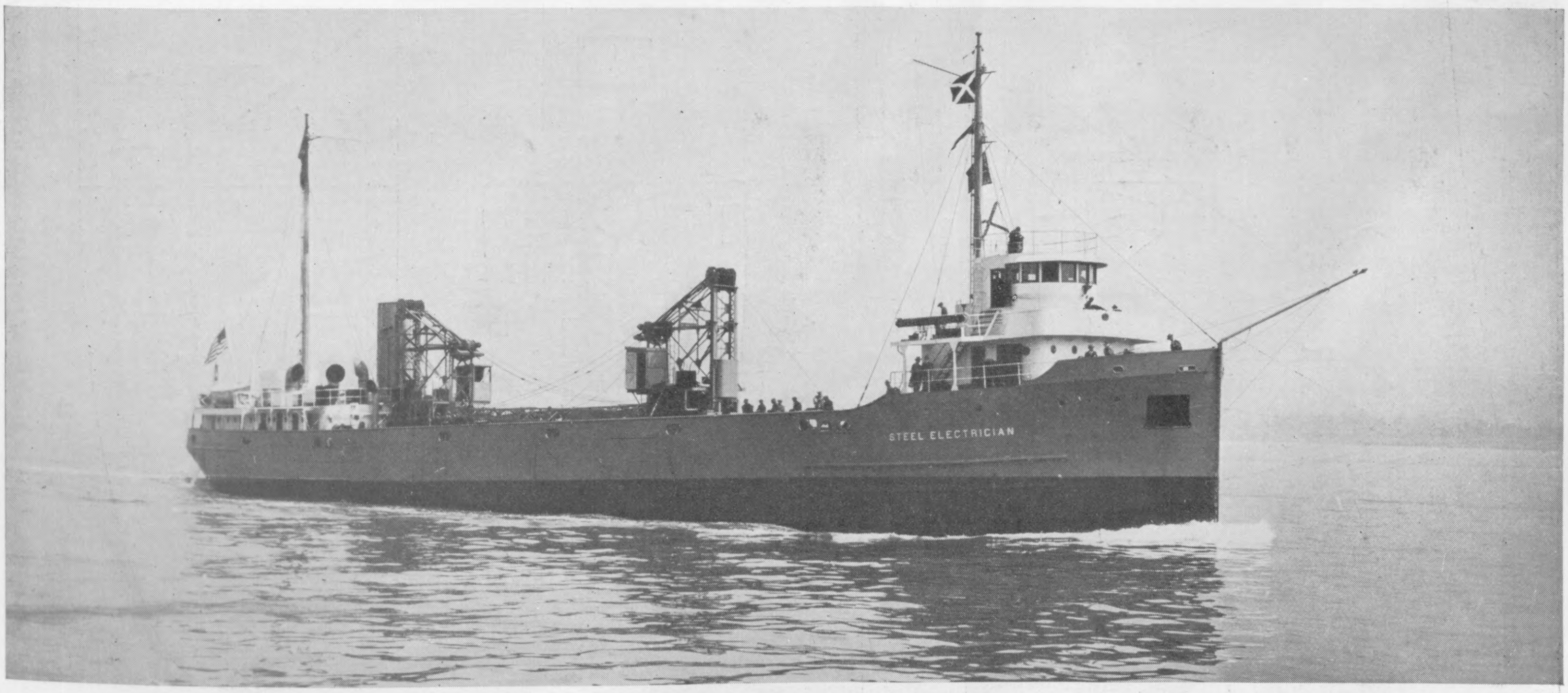
Characteristics of Ms. Steel Electrician

Length overall	257 ft. 11⅝ in.
Length, b.p.	250 ft. 0 in.
Beam, molded	42 ft. 9 in.
Depth, molded	20 ft. 0 in.
Draft, Lake service	14 ft. 0 in.
Draft, coastwise	16 ft. 0 in.
Gross register	1694 tons
Main Engines (3)	900 b.hp.
Electric propulsion motors	750 s.hp.

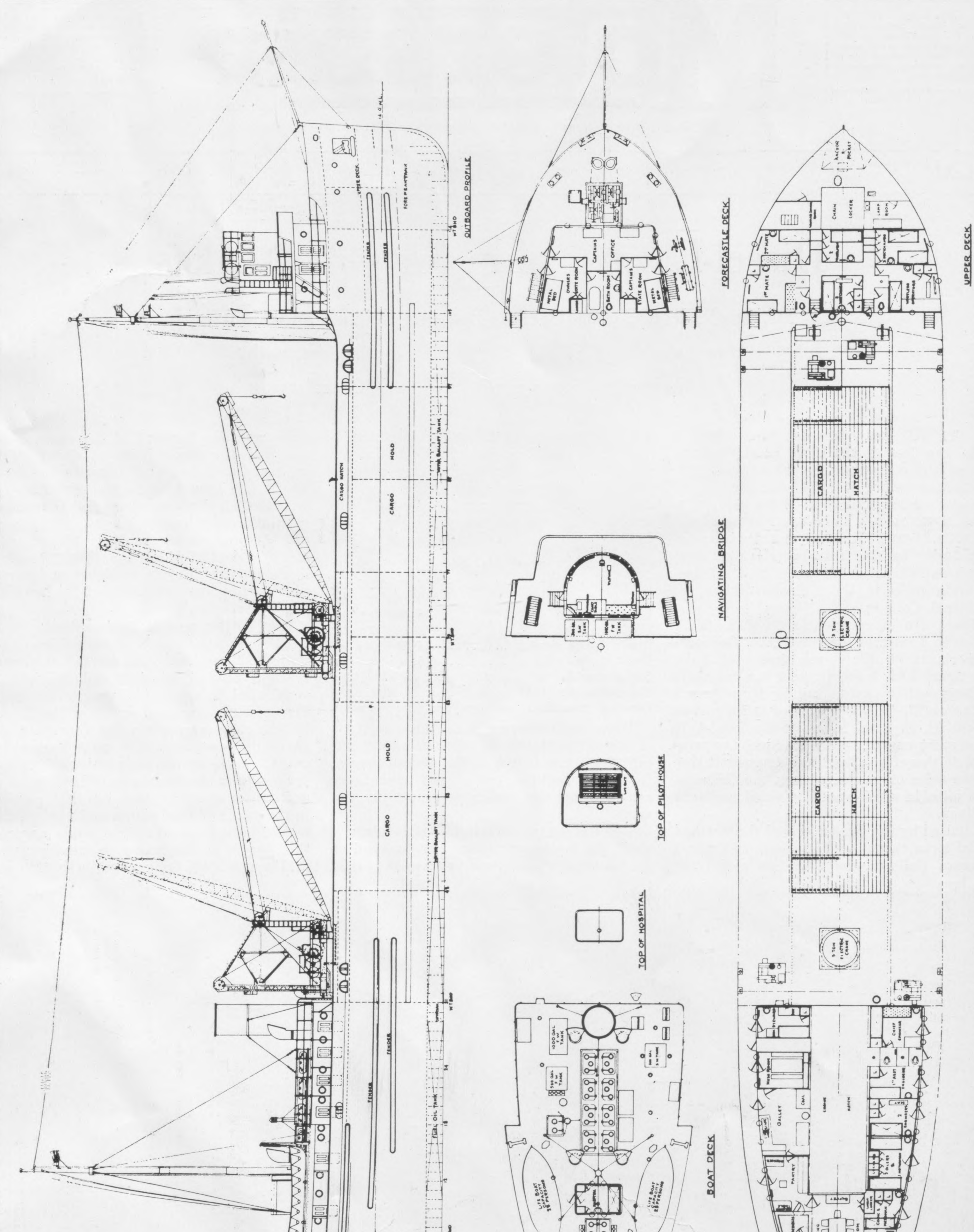
These are the same dimensions as those of the STEELMOTOR and STEELVENDOR, except for a few inches in the overall length. In every feature except the machinery arrangement the design is practically the same.

There are four watertight bulkheads, one abaft the machinery space, one forward of the machinery space, one between the cargo holds and one forward of the cargo space. Each of the cargo holds is about 80 ft. long, and each has a hatch measuring 40 ft. by 20 ft. Into both holds, therefore, can be loaded steel plates, structural shapes and rails of large length, for which railroad and shipping companies make extra charges and shipment of which by ordinary services is frequently subject to delay and sometimes impossible on account of the handling difficulties.

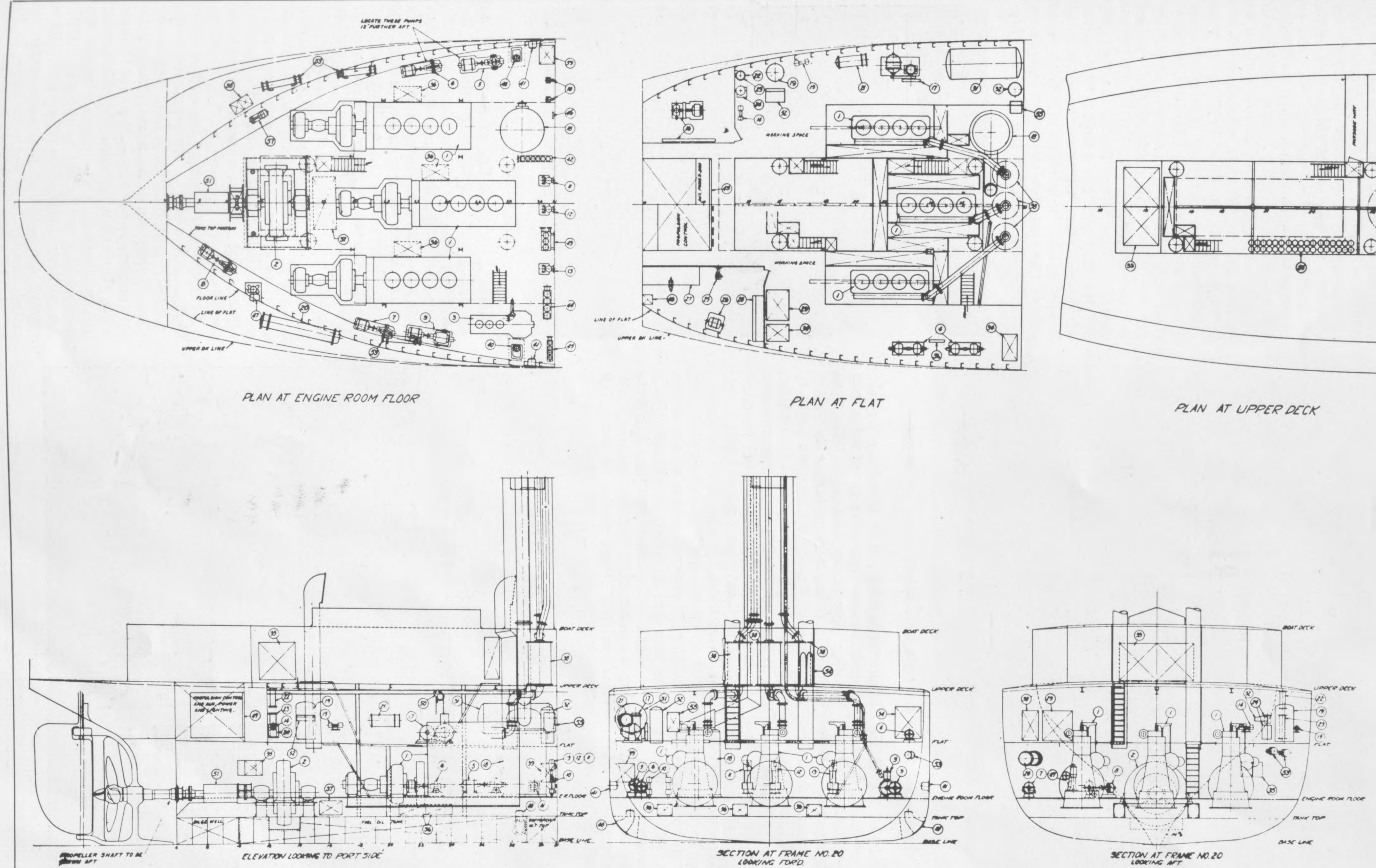
For lifting and swinging these large lengths special handling provisions are made on these boats. The usual shipboard arrangement of winches and derricks is supplanted by two 5-ton electric revolving cranes of the standard design of the Brown Hoisting Machinery Co., of Cleveland, O., generally used on land as a locomotive crane. These cranes are particularly suited for handling steel products in large lengths, and are extensively used for that purpose in the yards of steel plants and engineering works. They are, of course, more powerful than would be necessary in handling general cargo, but their superiority for use



Ms. Steel Electrician and her 3 prototypes are specialist Great Lakes Ships. They handle and transport steel mill products

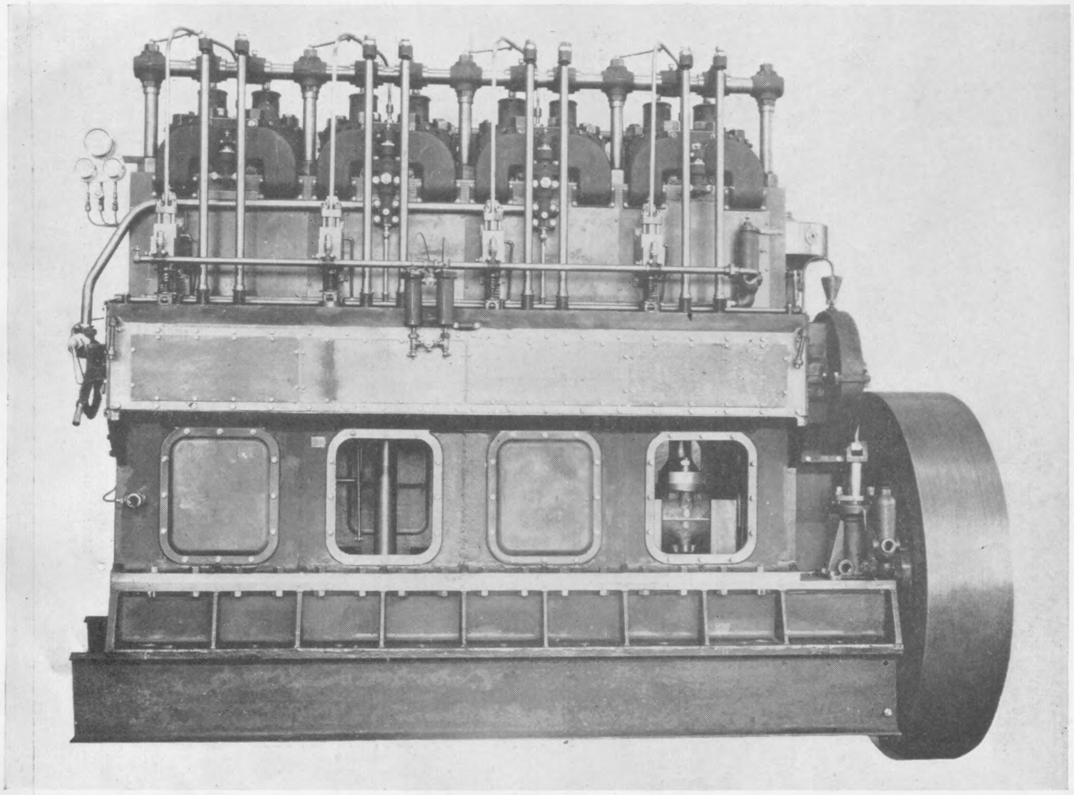


General arrangement of the Motor Lake and Canal Freighter Steel Electrician differs in cargo-handling arrangement from normal practice, but is similar to that of her 3 prototypes



Ms. Steel Electrician's Diesel-electric drive permits of a compact machinery space arrangement. A contra-propeller improves propulsive efficiency

1—(3) Main Gen. sets.
2—Propelling motor.
3—Aux. Gen. set.
4—(2) Motor Generators.
5—S. W. Circ. Pump (Sea).
6—S. W. Circ. Pump (Port).
7—F. W. Circ. Pump (Sea).
8—F. W. Circ. Pump (Port).
9—Fire and G. S. Pump.
10—(2) Donkey boiler feed pumps.
11—Bilge and Emergency O. F. transfer pump.
12—O. F. transfer pump.
13—Lub. oil standby and transfer pump.
14—Distilled water pump.
15—Hot water circ. pump.
16—Ice machine and condenser.
17—Air compressor.
18—Donkey boiler.
19—Hot water storage heater.
20—F. W. cooler.
21—Condenser.
22—Distiller.
23—Evaporator.
24—Distilled water tank and strainer.
25—Hand drill.
26—Motor-driven grinder.
27—Work bench
28—Bins.
29—Lub. oil storage tank.
30—Lub. oil settling tank.
31—Starting air tank.
32—Whistle air tank.
33—O. F. daily service tank.
34—Kerosene tank.
35—Engine room oil tank.
36—(3) Lub. oil drain tanks.
37—F. W. drain tank.
38—(3) exhaust silencers.
39—Feed and filter tank.
40—(2) Low sea chests.
41—(2) High sea chests.
42—Bilge manifold.
43—Fuel oil cock manifold.
44—Ballast manifold.
45—Ballast manifold (wing suction).
46—Donkey boiler feed injector.
47—Lub. oil separator.
48—Clean waste tank.
49—Switchboard.
50—(3) Trolley chain hoist.
51—Thrust bearing.
52—Log desk.
53—Lub. oil coolers.
54—Lux Bottles (34).
55—Inspection tank.
56—Lighting switchboard.
57—Prop. motor bearing pump.



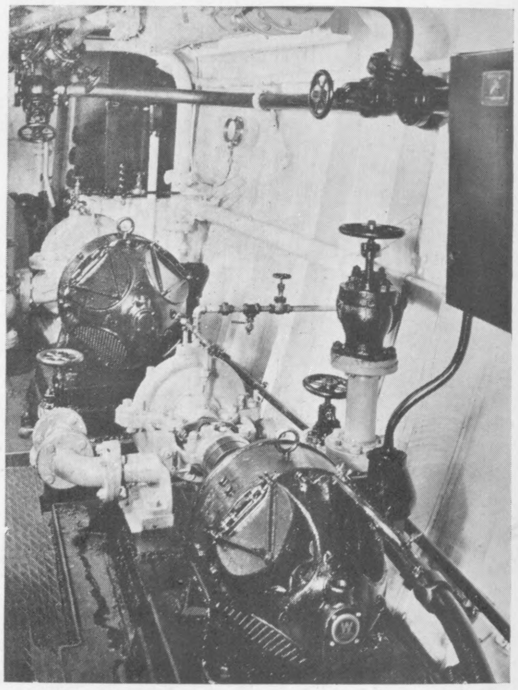
Diesel engines of 300 b.hp. coupled to 200 kw. generators supply propulsion power

on the Welland Canal boats of the U. S. Steel Products Co. have been amply demonstrated by the service they have given on the STEELMOTOR and STEELVENDOR. Illustrations of these cranes in operation on the two earlier ships were published in Oct., 1923, MOTORSHIP.

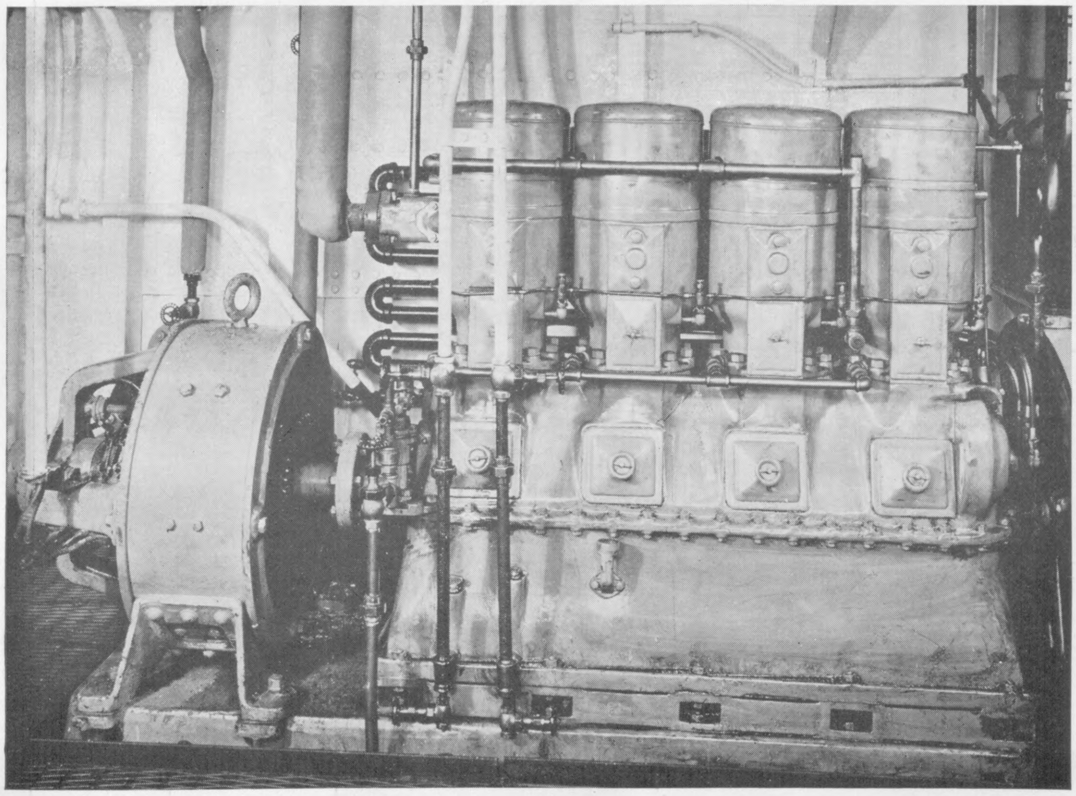
Being intended primarily for service between Chicago and Montreal and only secondarily, if at all, for coastwise service, STEEL ELECTRICIAN follows the usual Lakes practice of machinery aft, with quarters for the engineroom staff in the after deckhouse and with the wheelhouse forward with accommodation for the deck officers and deck hands. The classification of the American Bureau permits these vessels to be used in coastwise service but in actual practice the alternative does not seem to afford a real benefit. Experience had with Lake type boats in coastwise service during the winter months when the Great Lakes are closed to navigation has not been very encouraging, the fact being that a boat for winter coastwise service can be built better to other dimensions than those limited by the Welland Canal locks.

For all practical purposes, therefore, the U. S. Steel Products Company's Lake motorships can be regarded as Lakers wholly and alone. The first two boats STEELMOTOR and STEELVENDOR were single screw vessels with a Diesel engine of about 750 b.hp. direct connected to the propeller shaft. These engines, which turn at 135 r.p.m. gave the vessels a speed of about 9 knots on their Lake draft of 14 ft. In the course of service it was found that these engines could not be slowed to the minimum desired by the operators and arrangements have been developed for operating the engines on three of their six cylinders when going through the locks or in other restricted waters where extremely low speed is a necessity. Even with these arrangements, however, as low a speed as desired has not yet been obtainable.

When the U. S. Steel Products Co. decided last year to order two more boats for the service between Chicago and Montreal they chose Diesel-electric propulsion for one vessel and double-acting engines for the other. The vessel with the Diesel-electric system is the STEEL ELECTRICIAN, and the ship with the double-acting engine will be the STEEL CHEMIST, which is to be delivered later this summer. Both these vessels, like their two prototypes, have been designed and built by the Federal Shipbuilding & Drydock Co., of Kearny, N. J., and the selection and installation of the machinery was left in the same company's hands. For STEEL ELECTRICIAN the builders chose what they considered the most flexible form of Diesel-electric drive, namely, the power voltage control form. Flexibility has been considered of prime importance in view of the operation of STEEL ELECTRICIAN through rivers and canals, and in waters where she goes abruptly into strong currents. The power voltage control system is held to afford the highest refinement of control and is stated to utilize the simplest arrangement of apparatus and of electrical circuits.



F. W. circulating pump

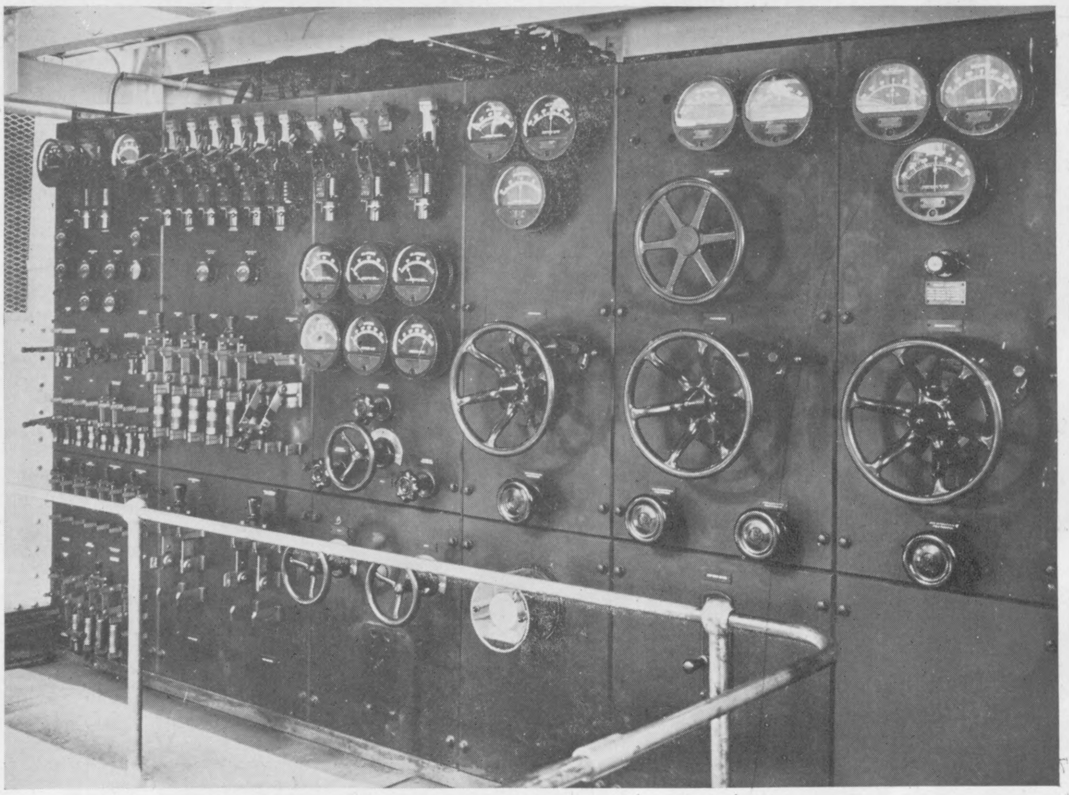


A 25 kw. generating set in the starboard engine room wing is for standby

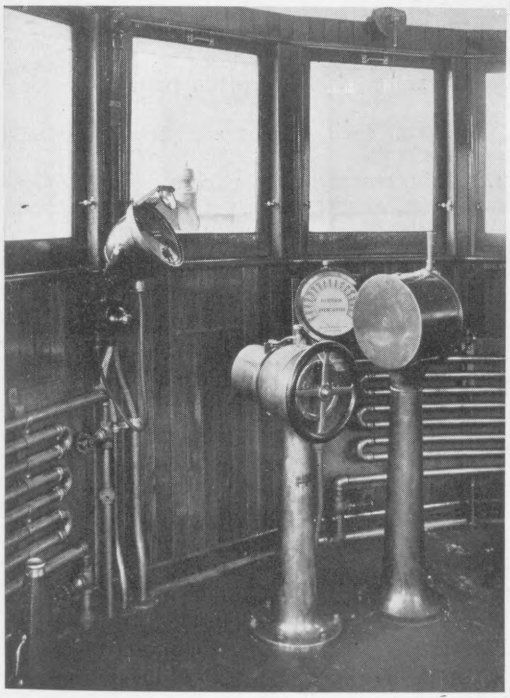
Regardless of whether the ship is operated in still water or in strong currents, or passing intermittently from one to the other, the captain of the STEEL ELECTRICIAN has complete and positive control of the propeller revolutions because with this system the revolutions of the driving motor are substantially unaffected by the load. With this system installed on the STEEL ELECTRICIAN the speed of the propeller can be varied directly from the pilot house in 50

progressive steps of less than 3 r.p.m., each from the full speed of 135 revolutions to a dead slow creeping speed. This range of control is available both ahead and astern. The ability to regulate the speed directly from the pilot house in such small increments and over the entire range from zero to the maximum makes a strong contrast with the older style system of guessing at a time that will be taken for a response to be given to a signal sent down to the engineroom, where at the best only abrupt and relatively big differences of propeller speed can be obtained.

In the STEEL ELECTRICIAN the captain operates the vessel in exactly the same manner as a driver operates an automobile. He has positive and instant control of the maneuvers and the vessel is steered and controlled directly instead of being "jockeyed" into position. This positive and instant control of maneuvers is expected to enable the vessel to make better time in its operation through restricted waters. Also, the captain having complete command of the progress of the vessel at all times



Main and auxiliary switchboard, a 5 panel unit, is on a flat in the engine room

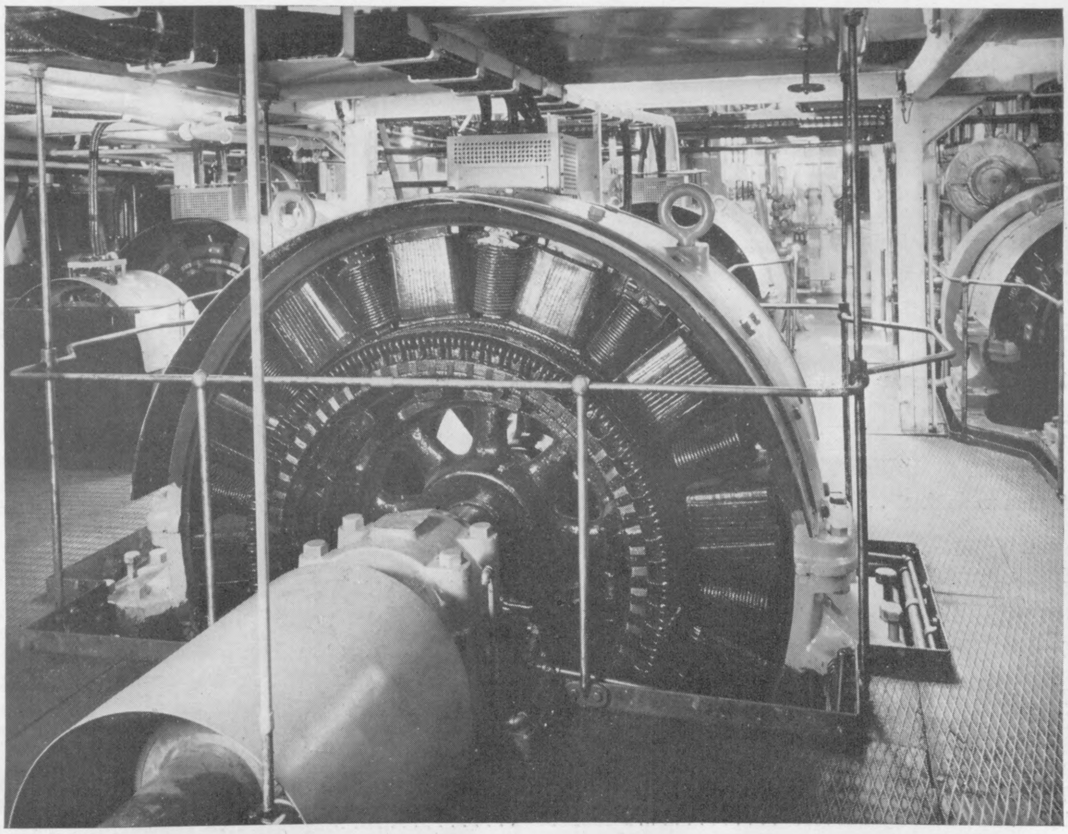


Pilot house control

instead of having to estimate its possible position after a signal given to the engineroom can be counted on to work the vessel into or out of locks without damage. The hazard of working through locks is almost entirely a hazard of communication between bridge and engineroom. The refinements of control provided in the STEEL ELECTRICIAN are such that the owners and builders anticipate that this vessel will perform in a given time the same work that a direct connected Diesel vessel of appreciable greater s.hp. could do.

For the main propulsion there is a 750 hp. d.c. electric motor turning the propeller at 135 r.p.m. The power is supplied by three generator sets, each consisting of a 300 b.hp. 4-cylinder Nelseco airless-injection engine direct connected with a 205 kw. Westinghouse d.c. generator turning at 225 r.p.m. These generator sets are arranged abreast of each other and the engineroom control and switchboard is located on a platform directly above the propelling motor, thus giving the switchboard attendant a complete view of all the main machinery. The three main Diesel engines were built by the New London Ship & Engine Co., of Groton, Conn., and are of the new M.A.N., 4-cycle type with airless injection. In these engines the block style of construction is used, the cylinder liners being inserted into a single casting surmounting the crankhousing and bedplate. Steel tie bolts extending from the top of the cylinder block to the bedplate hold the structure rigidly together. The rigidity thus obtained assists materially towards the attainment of smooth running and the elimination of the vibration. With the M.A.N. airless injection a very remarkable economy of fuel has been attained. Tests carried out at the Nelseco Works and on engines in service show that the fuel consumption of this new type Nelseco engine is approximately 10 per cent to 12 per cent lower than what is considered the average for engines of this size. This fuel saving amounts to a considerable item in the course of a year's operation. At full power each engine will consume approximately 15 gal. of fuel oil per hour.

The propelling motor, generators and exciters are of the self-ventilated, open type, with drip-proof canopy covers. The motor and generators are of the pure shunt



A single armature main motor turns the 10 ft. 0 ins. dia. propeller at 135 r.p.m.

Details of Machinery Equipment of Lake Freighter Steel Electrician 250 ft. b.p., 2077 tons d.w.c., 750 s.hp.

ITEM NO.	NAME	MAKE	QUANTITY	CHARACTERISTICS
	PROPELLING MACHINERY—DIRECT.			
1	Propelling motor	Westinghouse	1	Open, single armature, 135 r.p.m., 690 volts, 750 s.hp.
2	Propeller	Federal	1	Built up Mang. Bronze, 10 ft. 0 in. dia. x 7 ft. 11¼ in. pitch, pitch ratio = 0.793, 4 blades.
3	Propeller shaft	Federal	1	Solid forged steel, 9½ in. dia. Removable coupling.
4	Stern tube	Federal	1	One piece C-I, 16½ in. outside dia. x 6 ft. 11 in. long.
5	Thrust shaft	Federal	1	Solid forged steel, 10 in. dia.
6	Thrust bearing	Kingsbury	1	Single collar, 2 shoe, 21 in. dia. collar, 279 lb. per sq. in. Thrust pressure max., 23, 650 lb. Max. thrust. Steady bearing at one end.
7	Switchboard	Westinghouse	1	Ebony asbestos, 5 panel, also for auxiliary control.
8	Control (main motor)	Westinghouse	1	Ward-Leonard, 690 volts. Operating stations in pilot house & engine room.
9	Contra-propeller	Federal	1	Star, 4-bladed, 6 ft. 6 in. dia.
	PROPELLING MACHINERY—INDIRECT.			
10	Main generator engines	New London	3	4-cyl. solid injection, single acting, 15 in. x 22 in., 225 r.p.m., 300 b.hp. each.
11	Main generators	Westinghouse	3	200 kw., direct current, 230 volts, 225 r.p.m. Each direct connected to one main engine.
12	Exciters	Westinghouse	3	30 kw., direct current, 230 volts, 225 r.p.m. Each attached to one main generator.
	COMPRESSORS.			
13	Compressor	Worthington	1	2-stage chain driven, 7 in.-6 in. x 6 in., 17 hp. motor, 350 lb. per sq. in. working pressure. 400 r.p.m., 30 cu. ft. free air, 53.5 cu. ft. piston displacement per min. Automatic control.
	PUMPS.			
14	F.W. circ.—sea	Worthington	1	Centrifugal, 2 in.-7½ hp. motor, 40 lb. per sq. in., 175 g.p.m.
15	F.W. circ.—port	Worthington	1	Centrifugal, 2 in.-5 hp. motor, 30 lb. per sq. in., 75 g.p.m.
16	S.W. circ.—sea	Worthington	1	Centrifugal, 2 in.-15 hp. motor, 30 lb. per sq. in., 400 g.p.m.
17	S.W. circ.—port	Worthington	1	Centrifugal, 2 in.-5 hp. motor, 30 lb. per sq. in., 150 g.p.m.
18	Fire and general service	Worthington	1	Centrifugal, 2-stage, 3 in.-25 hp. motor, 300 g.p.m. on ballast service; 200 g.p.m. on fire service.
19	Lub. oil	New London	3	Attached, 10 lb. per sq. in., 14 g.p.m. each, one on each main generating set.
20	Lub. oil, standby and transfer	Worthington	1	Vertical simplex, 6½ in-7 in. x 8 in. steam, 40 lb. per sq. in., 50 g.p.m.
21	Fuel oil transfer	Worthington	1	Vertical simplex, 6½ in.-7 in. x 8 in. steam, 75 lb. per sq. in., 60 g.p.m.
22	Bilge & Emergency fuel oil transfer	Worthington	1	Vertical simplex, 6½ in.-7 in. x 8 in., 75 lb. per sq. in., 90 g.p.m.
23	Distilled water	Worthington	1	Horizontal duplex, 3 in.-2 in. x 3 in., 40 lb. per sq. in., 9 g.p.m.
24	Hot water circulating	Worthington	1	Vertical simplex, 4 in.-2½ in. x 4 in., 150 lb. per sq. in., 4½ g.p.m. each.
25	Donkey boiler feed	Worthington	2	Double Tube, ½ in. pipe conn., 125 lb. steam, 1500 lb. water per hr.
26	Injector	Metropolitan	1	
	HEATERS & COOLERS.			
27	Donkey boiler	Federal	1	Vert. fire tube type oil burner, 5 ft. 3 in. dia. x 9 ft. 0 in high, 355 sq. ft. total heating surface. Working pressure 125 lb. per sq. in.
28	Condenser	Federal	1	Cylindrical, surface, 75 sq. ft. cooling surface. Welded steel plate, C-I water ends.
29	Hot water storage heater	Federal	1	Coil, 14.5 sq. ft. heating surface, 25 lb. per sq. in. w.p. 156 g.p.m. from 60 deg. F.-130 deg. F. Fitted with thermostat control.
30	Drinking water set	Griscom Russell	1	Coil, 600 gal. per day.
31	Lub. oil coolers	New London	3	Attached, 110 deg.-105 deg. oil, sea inlet 85 deg., 146 g.p.m. each, oil, 186 g.p.m. water.
32	Fresh water cooler	Andale	1	Counterflow, straight tube, 400 sq. ft. cooling surface, 150 deg.-120 deg. F.W., 85 deg.-105 deg. S.W., 205 g.p.m., F.W. 306 g.p.m. S.W., C-I shell, C-I heads.
	ELECTRICAL EQUIPMENT.			
33	Secondary generator set	Hill-Westinghouse	1	15-25 kw., direct current 230 volts, 4⅜ in. x 8 in. kerosene engine.
34	Motor generators	Westinghouse	2	Motor 230 volts, generator 115 volts, 7½ kw. each, for lighting circuit.
35	Helm indicator	Hyde	1	230 volts, d.c., 115 volts a.c., to show 40 deg. each side of center.
36	Whistle control	Signal & Control Co.	1	Full automatic, 110 volts d.c., for 1 air whistle.
37	Radio outfit	R.C.A.	1	Tube, 200 watts.
38	Storage battery	Philco.	1	Lead plate, 60 cell., 120 volts.
39	Switchboard—(lighting)		1	Marine, slate.
	HULL AUXILIARIES.			
40	Cargo cranes	Brownhoist	2	3 motor, revolving, 65, 25, 15 hp. motors, 230 volts d.c., lift 5 tons at 130 ft. per min. 50 ft. rad., Cutler Hammer control.
41	Steering gear	Hyde	1	230 volts, hydro-electric, 7 in. dia. Rudderstock, 6 hp. motor, 7 in. dia. rams.
42	Warping winches	Hyde	4	Single geared, 15 hp. motor.
43	Anchor windlass	Hyde	1	Spur geared, 35 hp. motor, 2 anchors each with 30 fathoms of 1-11/16 in. chain, at 25 ft. per min.
44	Ice machine	Brunswick-Diehl	1	Ammonia, 2 hp. motor, constant speed, ½ ton per day, Cutler Hammer control.
	TANKS.			
45	Starting air	Federal	1	Riveted Steel plate, 4 ft. 0 in. dia. x 10 ft. 0 in. long, 350 lb. per sq. in. working pressure, 126 cu. ft. capacity, 1710 cu. ft. air available, = 19 starts of 1 generator engine.
46	Whistle air	Federal	1	Lapwelded Steel shell, 22 in. dia. x 4 ft. 2 in. long, 125 lb. per sq. in. working pressure, 10 cu. ft. capacity.
47	Lub. oil drain	Federal	3	Welded Steel plate, 60 gal. ea., 4 min. supply.
48	Lub. oil settling	Federal	1	Welded Steel plate, 190 gal., 4 min. supply, fitted with gage glass and heating coil of 6 sq. ft. heating surface.
49	Lub. oil storage	Federal	1	Welded Steel plate, 360 gal., 40 days' supply.
50	Engine oil	Federal	1	Welded Steel plate, 2 compt., 60 gal. total.
51	Fuel oil daily service	Federal	1	Riveted Steel plate, 2 compt., 6 tons total. Fitted with calibrated gage and heating coils of 27 sq. ft. heating surface, 35 hr. supply.

Details of Machinery Equipment of Lake Freighter Steel Electrician 250 ft. b.p., 2077 tons, d.w.c. 750 s.hp.—*Contd.*

52	Kerosene	Federal	1	Riveted Steel plate, 200 gal. for secondary generator engine. Fitted with connection to fuel oil supply lines for flushing.
53	Clean waste	Federal	1	Riveted Steel plate, 5 cu. ft.
54	Feed & filter	Federal	1	Riveted Steel plate, 50 gal., fitted with perforated steam pipe for direct heating.
55	Fresh water (drain)	Federal	1	Riveted Steel plate, 300 gal.
	MISCELLANEOUS.			
56	Exhaust silencers	New London	3	Steel plate, 9 in. connection.
57	Lub. oil purifier	De Laval	1	Cent. 220 volt motor, 1½ hr. to purify one complete batch.
58	Fuel oil burner	Todd	1	Rotary, gravity feed, forced draft, 200 lb. oil per hr. max., automatic control.
59	Air Whistles	Hallings	2	Tyfon, 125 lb. working pressure steam or air, one with electric, both with manual control.
60	Engine room gong		1	Trip, 16 in. emergency engine room signal.
61	Exhaust gas pyrometer		1	Thermocouple, 15 point selector switch, couples at each main eng. exhaust port.
62	Fuel oil strainer		1	Duplex, 2 in.
	WORKSHOP MACHINERY.			
63	Drill press	Hammacher-Schlemmer	1	Hand drive, Drills ¼ in.-1¼ in. inc.
64	Emery grinder	Hisey-Wolf	1	Motor driven.
65	Lathe		1	Motor driven.
	VALVES.			
66	Hot water pump governor	Foster	1	Diaphragm, ⅜ in., set at 35 lb., limits 20 lb.-45 lb.
67	Reducing valve-heating system	Leslie	1	Spring loaded, 1½ in., 125 lb.-25 lb.
68	Reducing valve for air to whistles & pumps	Leslie	1	Spring loaded; 2 in., 350 lb.-100 lb.
69	Boiler safety valve	Starr Brass	1	Spring loaded, 2 in. single relief, 125 lb. working pressure, 2130 lb. steam per hr.

type, connected in series and arranged for the full voltage control system. A potentiometer type rheostat is employed for varying the generator field excitation from zero to full value in either direction. The motor is excited at constant value and in one direction. Under this condition, a variation in the generator excitation will produce a like variation in the motor speed, and hence the propeller speed. The complete control of the propeller, therefore, is effected remotely from the pilot house by handling only the small field current of the generators and without opening a circuit of any kind. A duplicate control station is arranged at the switchboard in the engineroom for emergency use.

The control set-up is so arranged that any combination of main engine generator sets may be used for propulsion and also provides for using any one of these sets for supplying the cargo-handling equipment and auxiliary power when the vessel is in port. The voltage control system as installed, makes it possible to utilize the full engine capacity of any number of sets that are in operation. On the basis of the propeller power varying as the cube of the speed, two of the three engine sets are sufficient to drive the vessel at 88 per cent speed, while one of the engine sets will furnish sufficient power to drive the vessel at 70 per cent speed.

The arrangement for utilizing the main engine generator sets for auxiliary power in port obviates the necessity of carrying auxiliary generators. This vessel, therefore, carries only a small auxiliary oil engine generator set of 15 kw. capacity, which will be used chiefly when the vessel is laid up.

The control switchboard in the engineroom is arranged in six panels. The three panels on the port side control the various set-ups of the main generating plant. Each generator is provided with a three-position switch operated manually by means of a hand-wheel on the front of the panel. The hand-wheel is provided with a notched disc so that the switch may be latched in any of its three positions. Incidentally, the latch handle is provided with an interlock which opens the generator excitation circuit whenever the latch is disengaged from the notch, thus assuring that the main circuit is de-energized whenever switching operations are made. One position connects the generator to the auxiliary bus for supplying the cargo-handling machinery when in port. The third position places the generator out of all active circuits and simultaneously continues the series circuit for the remaining portion of the plant when set up for propulsion. The hand-wheel at the top of the center panel of the propulsion group operates the emergency control of the propulsive plant.

STEEL ELECTRICIAN is the first vessel to be provided with an automatic power limit control. The object of this device is to limit the power developed by the engines to a predetermined value, so as to prevent detrimental overload. This device functions in such a manner as not to interfere in the least with the maneuvering of the vessel. The switch handle at the bottom of the center panel of the propulsion group delegates the control to the pilot house or to the engineroom when moved to the lower or upper positions respectively.

Control for the auxiliary circuits follows, in general, the usual marine practice. There is a feature, however, worthy of special mention, namely, the arrangement for energizing the various auxiliary buses. There are five auxiliary busses, three of which are auxiliary power buses (such as excitation, lights, and steering gear; engineroom auxiliary machinery, and deck machinery) and one main generator auxiliary power feeder bus, and one auxiliary generator feeder bus. The three auxiliary power buses are supplied normally by the three 30 kw. exciters. The circuits of each auxiliary power bus are handled by a wheel-operated cam contactor switch group. This group provides for placing that bus on any of the three exciters. The arrangement is inherently such as to prevent paralleling of the exciters. Complete flexibility of the auxiliary plant is provided, therefore, in the simple, fool-proof arrangement of this type.

From the list of machinery detailed in this article, and from the engineroom layout a reader can gather all the essential details of the auxiliary equipment. Comment need be added only on two or three points. For instance, the revised rules of the American Institute of Electrical Engineers relating to marine installations requires a double system of lubrication on electric propelling motors. The Federal S. B. & D. D. Co. has therefore installed a rotary pump of the American Machine & Foundry Co. type with a capacity of 10 gal. per min. at 5 lb. pressure to supplement the ring oiling installed by the electrical manufacturers. A pump is installed to get rid of water that might accumulate in the recesses in the propulsion motor because that space cannot be drained. The foundation under the motor is watertight and a plate surrounds the motor to a height of 6 in. above the floor to prevent water draining into the recesses. Water might get in accidentally and the pump is provided to get it out.

STEEL ELECTRICIAN has been finished in line with the most progressive practice, equipped with all modern appliances tending to reduce hazards of operation or adding to efficiency. All deck machinery and the steering gear are, of course, electrically operated. She is equipped with Lux apparatus for extinguishing fires, and she has a contra propeller. After completion at the builders' yard she ran only a short trial before starting for Montreal where she took aboard a cargo for Chicago and started thus on her regular service.

BELRAY, a single screw motorship of 4235 tons deadweight designed specially for the carriage of locomotives, was recently delivered to her owners, Rederiet Belnor A/S Oslo, by Sir W. G. Armstrong, Whitworth & Co., Ltd., Newcastle-on-Tyne. She is the third ship of this type constructed by Armstrongs for the same owners—the others being named BELDIS and BELNOR, respectively.

Big Shipyard Will Standardize Hulls

Harbor Craft and Dredges of Standard Design Offered by American Brown Boveri Electric Corp.

WITH the recent award of two contracts aggregating $3,479,000 to the American Brown Boveri Electric Corporation of Camden, New Jersey, one for 33 patrol boats at $63,000 each for the United States Coast Guard service and the other for six Diesel-electric ferries at $233,333 each—the corporation named is inaugurating a unique activity in standardized shipbuilding, which will be carried on in addition to its established business in built-to-order ships and smaller craft.

In the new department there will be designed, and in some cases built and placed in stock, standardized smaller craft and harbor improvement units under the various classified services beginning with ferries, yachts, car floats, dredges, barges, scows, etc. The prospective purchaser will thus in a short time be able virtually to step into the shipyard and pick out the type and size of floating unit he desires of quick delivery, visualizing exactly what he is buying and gaining the advantages of quicker delivery and of one profit manufacture on a production basis, available to him now only in the purchase of such everyday items as automobiles, motorboats, etc. A great latitude is still retained for him in a choice of powering details and outside fittings and finish, but the standardization of main parts and the best available composite engineering experience is embodied with the additional benefits of the ever important factors of lower price and quicker delivery.

Created with the title of Harbor and Dredge Dept. under the management of Colonel R. W. Berdeau, who has been actively associated with the design and purchase of craft of this character during long experience in this country, the Canal Zone and the Far East—the standardized hull division of the A. B. B. Electric Corporation is already functioning.

An example of the aims of this department can be furnished by reference to the plans for the standardization of dredges. There has been a considerable growth in the use of dredges by corporations and individuals. Formerly the U. S. Engineers Corps. was almost the sole user of dredges in this country. At the present time there is far more dredge construction in hand for private interests than for the Government, and this has been the situation for two or three years past.

A fiction that dredges were outside the laws and principles of naval architecture and marine engineering has gripped many prospective dredge owners in this country, leading them to assemble dredges with pontoons purchased at one place, structural steel fabricated somewhere else and machinery bought here and there without proper cöordination and without competent advice regarding the whole. Consequently problems of trim, stability, torsional vibrations, etc., having been given no prior consideration, have obtruded themselves most expressively when the assembly was finished and the owner due to start operations on a contract under heavy penalties for delay.

Actually a big dredge is as much of a naval architect's problem as a big passenger ship and the selection and arrangement of the machinery is in the province of the marine engineer. Dredges should therefore be built in shipyards with the responsibility on the shipbuilders.

If one examines dredge requirements one notes there is the difference between big dredges and big ships, that whereas very few ship services meet the same conditions, on the other hand nearly all dredges of the same class have similar requirements except in the matter of capacity. Taking dipper dredges, for instance, it can be urged that if three sizes are standardized with, say, 5, 7½ and 10 cu. yd. buckets, each of these dredges could work as well in the South as in the East. Why not, therefore, standardize them, effect the economies that can be derived from such standardized production and give a dredge operator the enormous advantages of purchasing a dependable unit at a lower price with a quicker delivery and the assurance of more rapid and less costly replacements of the wearing parts?

Or again suction dredges, for instance, can be standardized in 16-inch, 20-inch, 24-inch and 30-inch sizes probably, to cover the whole field. A dredge operator would not then be left to work out his own problems, with the expensive burden of delays and heavy outlays entailed by breakdowns that can be avoided by experienced advice.

Such dredges, of course, could not be carried in stock. That is not the intention. The design would be standardized, using as far as possible standard materials and fittings in stock in the yard or obtainable at short notice. There would be nothing experimental about them, and they could be built more rapidly and at a lower price than a special dredge.

Construction of hulls for stock will more likely be confined to smaller and less expensive craft, such as tugs, ferries, barges and scows. Analysis is being made of the modern trends in these various classes. Towboats may, for example, be classified according to power, because the measure of a towboat's utility is its ability to pull a certain tow at a certain speed, and with standard propellers that ability is a variable of power. Standards of 300 hp., 450 hp. and 600 hp. might be adopted, and one of these—the 300 hp. standard, for instance—being found in regular demand might be manufactured for stock.

Similarly in the case of ferryboats it is undoubtedly possible to concentrate on several boats of definite capacities that will meet the demands of many ferry services. Scows, barges and even carfloats can be standardized in a like manner.

Not every condition or requirement can be met by a standard boat, but undeniably standard boats will meet many conditions and requirements. Automobile owners long ago abandoned custom built bodies and truck owners today almost universally accept standard types of bodies. In the pleasure motorboat business the standardization system has spread very rapidly and very successfully, and yet only two or three years ago there was practically only one boatbuilder offering standard types.

A long period must elapse before the program of standardization which the American Brown Boveri Electric Corporation has inaugurated can be rounded out to completion, and even in its final form it will not fill everyone's needs. It is a definite attempt to lower the cost of new boats, but its scope must not be misunderstood. Many designs will be standardized for many different classes of boats, and a few types of boats will be manufactured and carried in stock. Shipbuilding in the Camden yard will also comprise the construction of individual ships to individual designs as heretofore.

It is planned to include the following classes of craft in the preliminary program:

A. B. B. Proposed Standardized Craft

Dipper Dredges	Floating Grain Elevators
Ladder Dredges	Ferries
Sea-going Suction Dredges	Drill boats
Pipeline Suction Dredges	Barges & Scows
Gold & Tin Dredges	Tenders, oil and water
Sand & Gravel Dredges	Tugs
Car Floats	Fire-boats
	Floating Cranes
	Floating Pile Drivers

Last of An Ore Fleet

Ten years ago Grangesburg-Oxelosund Co., one of Sweden's largest ore exporting concerns, planned and ordered a fleet of 18 ore-carrying ships from the Gotaverken Co., Gothenburg. All of these were originally intended to be steam driven, but actually only two were so completed, the remainder being propelled by Gotaverken-B. & W. engines, since it was found that the Diesel engine permitted of a much better distribution of cargo, as well as proving a more economical prime mover to operate. Owing to altered shipping conditions, Grangesburg-Oxelosund Co. cancelled the last 7 ships of the batch, leaving a total of 9 modern motor ore carriers. ERIK FRISELL, last of these 9, was launched at Gothenburg on May 5 and with her predecessor MURJEK differs from the preceding 7 motorships because she is of "three island" type with poop, bridge and forecastle. Her 7 sister units in the fleet are of shelter deck type, larger and more powerful.

The fact that the ocean-going tug BALDROCK had to have steam up and remain fully manned all the year round was held to make her work unprofitable owing to excessive maintenance charges. The Secretary of the United States and Bermuda Towing Company in discussing the sale of this vessel stated that underwriters in making compensation would not take this fact into account. It is questionable whether such a statement would have been necessary in the case of a Diesel engine.

Converted tug Cornell, the first towboat to have a reduction gear drive connected with a non-reversing Diesel engine

One Year's Operation of Geared Motortug

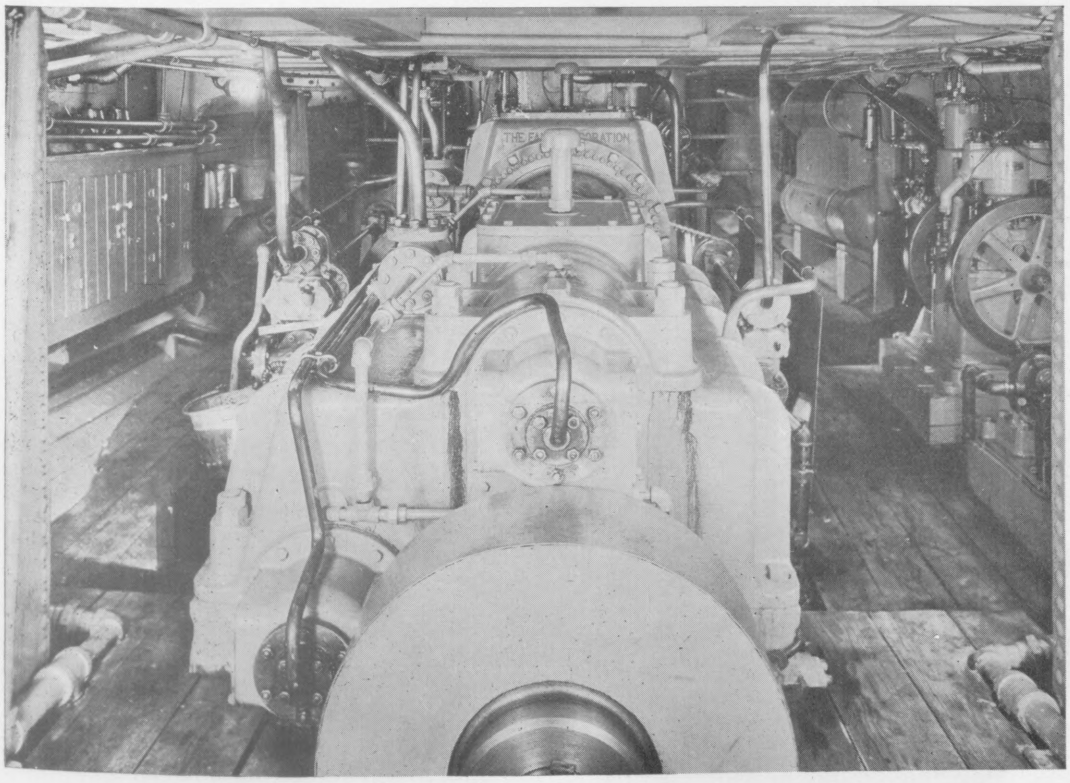
Success of Cornell Steamboat Company's Pioneer Geared Diesel Towboat Demonstrated by Excellent Service

CORNELL, a 300 hp. towboat with a gear reduction between the Diesel engine and the propeller, recently completed a full year's operation, without having been debited with any repairs. She has demonstrated beyond argument the soundness of the new features incorporated in her machinery installation.

CORNELL belongs to the Cornell Steamboat Co. of New York, which owns some 40 towboats of varying sizes and powers including one of 1400 i.hp., two of 900 i.hp., one of 700 i.hp. and four of 600 i.hp., among the latter being the JUMBO, which has direct Diesel drive. There are various other vessels of intermediate power ranging down to the small 50 hp. "polywogs" for creek work.

She measures 90 ft. on the keel, 17.3 ft. molded beam and has a hold depth of 7.2 ft. Her steam machinery was removed at the company's well-equipped service yard at Kingston-on-Hudson, and Diesel machinery was substituted. The main propelling engine consists of a 6-cylinder Nelseco non-reversible engine rated at 360 b.hp. at 230 r.p.m., which drives through the special reduction transmission gear a 4-bladed built-up bronze propeller 8 ft. diameter and 10 ft. 6 in. pitch. The engine has a fuel consumption of about 0.43 lb. b.hp.-hr. In order to receive this machinery the CORNELL was reconstructed and lengthened 18 ft.

The transmission gear consists of Falk reduction gearing designed for 360 b.hp. with a 25 per cent overload, the reduction ratio being 230 revolutions of the engine to 102 of the propeller. Control of the whole system is vested in a single lever, the movement of which regulates the speed of the main engine and also controls ahead and astern gearing by means of the operation of special clutches. There are two sets of reduction gears of helical type and two sets of clutches for ahead and astern running respectively.



Gearing and clutches of the Cornell are all enclosed: view from aft

Reference to the diagram makes the operation of the mechanism clear. The main—or speed reduction—drive is at the propeller end and consists of a set of double helical gears. The two single spiral gears between engine shaft and clutches serve as reversing mechanism and are practically even gears with a hunting tooth.

When the operating lever *1* is in the vertical position as shown on the diagram, both clutches are disengaged, and the engine, which is connected by means of a Falk-Bibby flexible coupling *2* with the upper gear shaft, runs idle, turning the reversing gears, but leaving the reduction gears and propeller shaft at rest.

Upon the order to go ahead, the operating lever is moved to the ahead position and piston *3* inside the clutch control valve *4* is caused to move down by action of the cam *5*, thus establishing a direct connection between the oil pressure tank *6* and the clutch *7* through the pipe lines *8* and *9* and the hollow shaft *10* forcing the clutch to engage. The engine torque is then transmitted through the clutch *7* and the pinion *11* to the main driving gear *12*. Gear shaft *13* being connected by means of another Falk-Bibby flexible coupling *14* to the propeller shaft *15*, a direct connection is established between the engine and the propeller, causing the boat to go ahead at the instant the clutch engages.

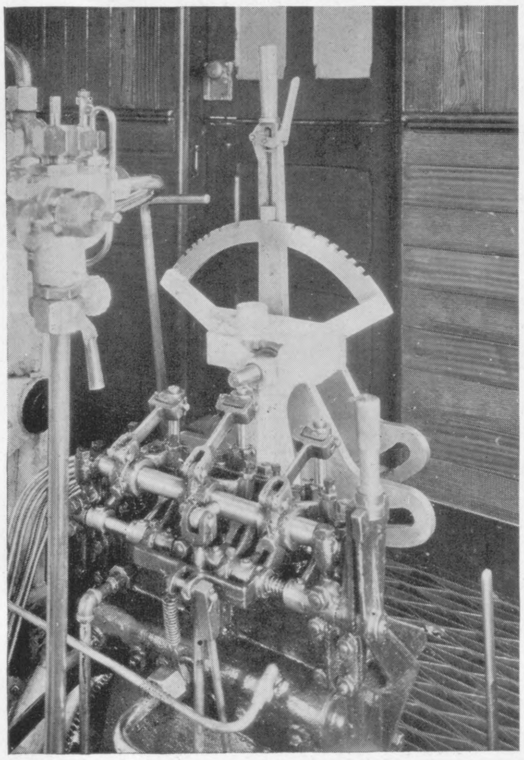
While only a slight shifting of the operating lever suffices to force the clutch engagement, further movement of this lever accelerates the engine speed gradually by means of the engine cam *16* and the fuel control lever *17*, until maximum propeller speed is obtained.

Upon the signal to stop, the operating

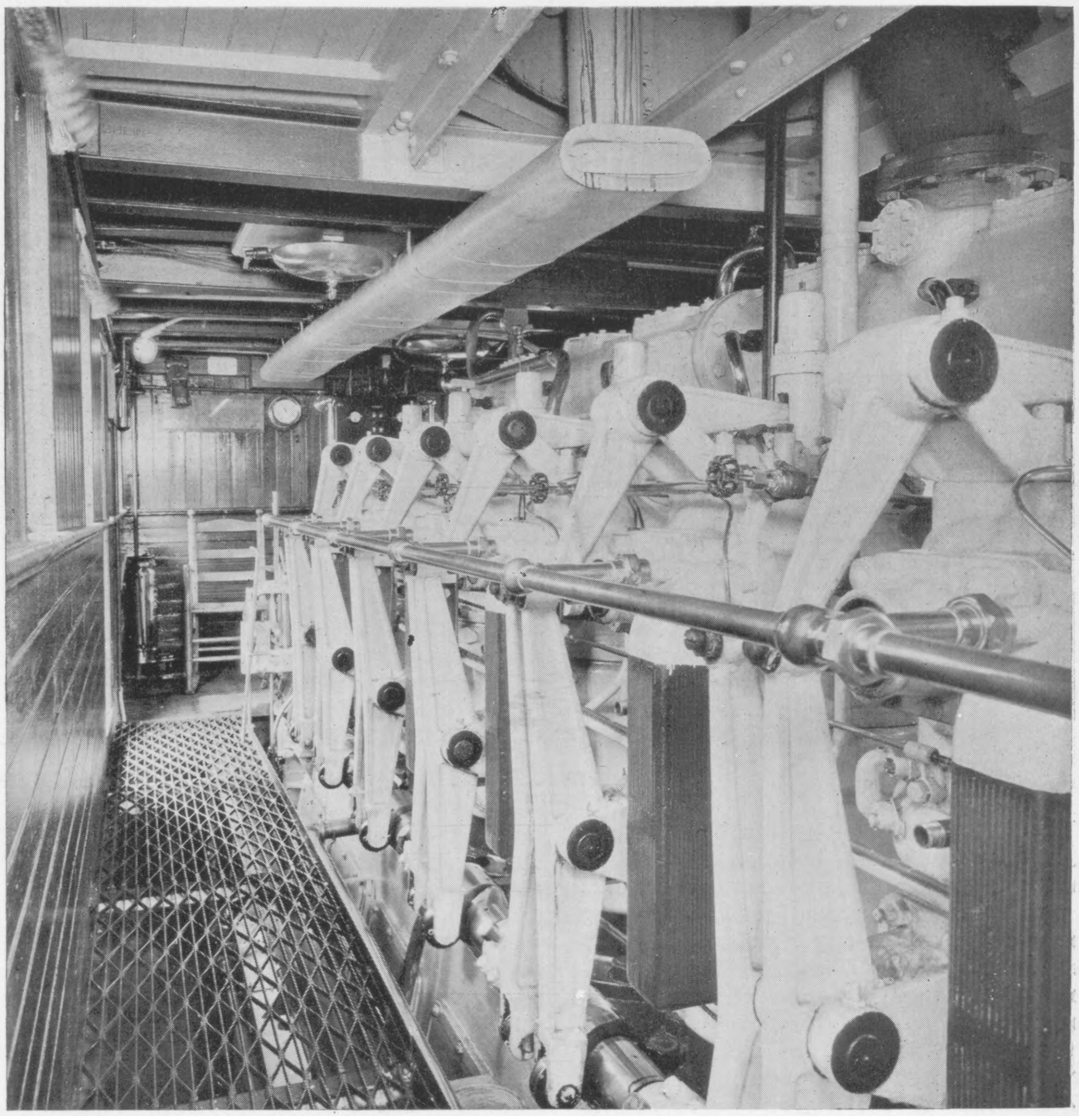
lever is thrust back into the vertical or neutral position. Consequently, the piston *3* connected with the cam *5* rises and cuts off the oil pressure from tank *6* and pipe lines *8* and *9* to the clutch *7*. The pressure release causes some of the oil in this system to drain through the by-pass pipe *18* into the sump tank *19*. The result is that clutch *7* disengages, thereby breaking the clutch connection between engine and propeller shaft. Engine and reversing gears then turn idly and the propeller stops rotating.

A pump *20* transfers the oil from the sump tank *19* through the pipe lines *21* to the pressure tank *6*.

Suppose the order is given to reverse. The operating lever is then thrown in astern position. Valve piston *3* rises and establishes direct communication between the pressure tank *6* and the clutch *22* by means of pipe line *23* and the bore through the shaft *24*. The oil pressure then compels the lower clutch to engage, so that the power is transmitted from the engine



A single lever controls engine and gears



Looking forward on port side of Cornell's engine room at deck level

through the reversing gears and pinion *25* to the main driving gear *12,* thereby operating the propeller in the opposite direction.

The time required to throw the drive from full ahead to full astern is about 2 sec.

Engagement and disengagement of clutches requires a slight axial movement of the reversing gears and their shafts. The single spiral reversing gears, in conjunction with the extensible Falk-Bibby flexible coupling, make such an end movement possible. The clutches are so constructed that upon their engagement the respective reversing gear and shaft move about 3/32 in. forward, compressing

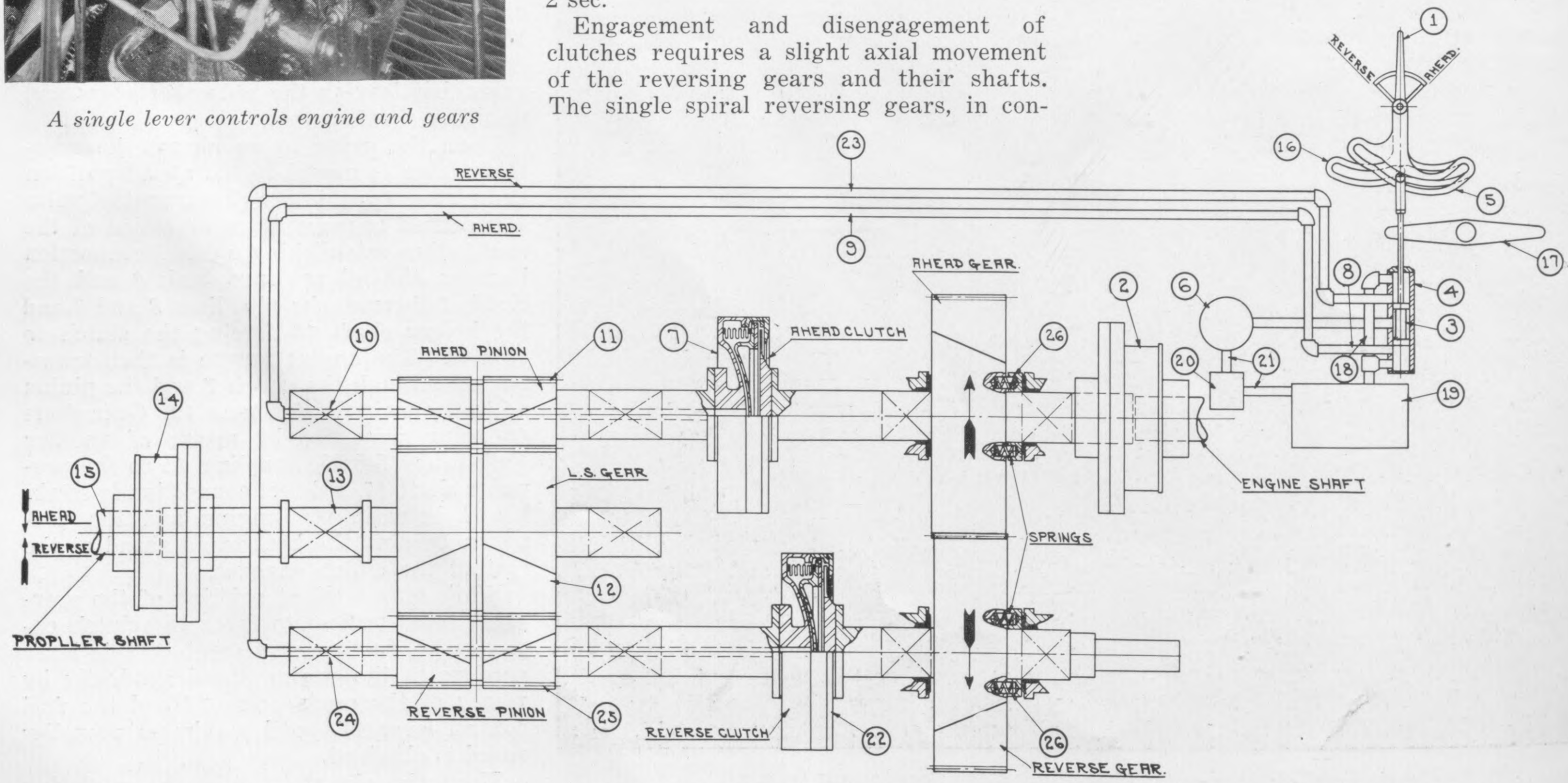
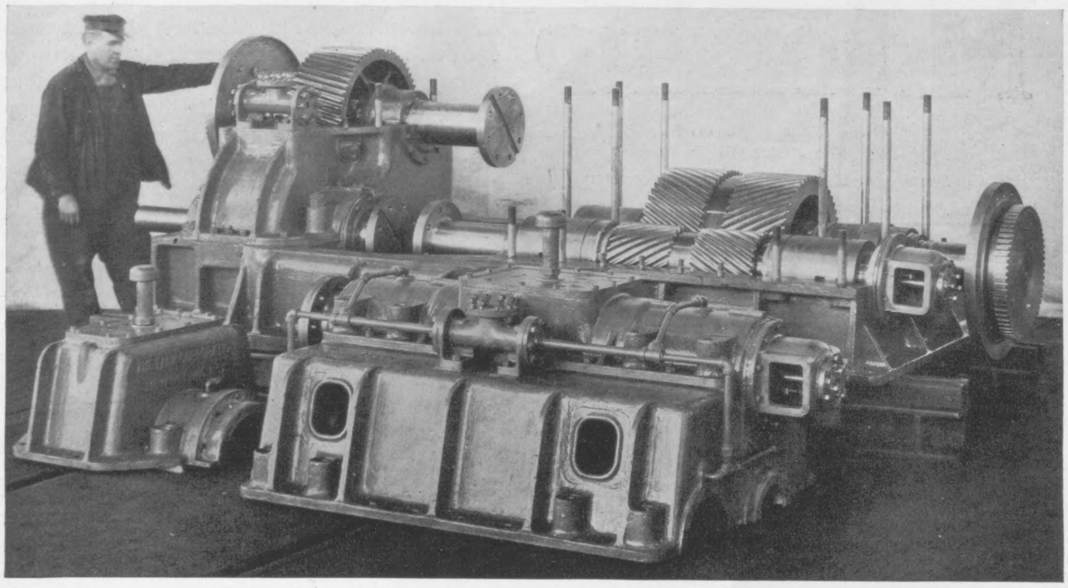


Diagram of reduction gears and clutches for ahead and astern and arrangement of clutch control in the Diesel towboat Cornell



Total of 360 b.hp. with a 2.25 to 1 speed reduction is transmitted through Cornell's gears

springs *26*. Upon clutch release the action of these springs forces the gears and shaft back into their original position.

Movement of lever *1* into the first notch on either side of the neutral position completes the engagement of the respective clutch and ensures the continuation of the drive ahead or astern, as the case may be. Further movement of this lever in either direction accelerates the engine speed gradually, by means of the engine cam *16* and fuel control lever *17*, until maximum speed in either direction of rotation of the main propeller is obtained. The further away from neutral position the lever is moved the more fuel is admitted into the cylinders and the greater is the speed of the engine.

A 4-cylinder oil pump *20* (which will also be noted in the illustration of the engine control) furnishes pressure for the system, and relief valves on both the clutch pressure lines get rid of excess pressure on the sump. Two Falk-Bibby flexible couplings, *2* and *14* in the diagram, are included in the system, and these permit operation with the shaft of the helical gears or of the engine as much as 3 deg. out of line. The clutches themselves, shown diagrammatically in part section, are of the Metten type, designed by W. Metten, chief engineer of the Cramp Ship & Engine Bldg. Co. and similar in principle to those used on the scout cruisers. They consist of fibre and steel discs pressed together by oil pressure led in through the hollow shafting.

The oil in the clutch control system is at 80 lb. working pressure, and at the present time the original oil is still in use and has only had to be made up by trifling amounts. The oil itself is of very light type. The clutches are faced with Thermoid frictionless brake lining, and although it was expected that it might be necessary to renew this every three months, the original material is still in use. The total pressure required to grip the discs is 25 tons.

As an example of the duty under which these clutches are expected to stand up the following incident is worth quoting. On Oct. 30, 1925, when going at full speed in Newtown Creek, the CORNELL picked up with her wheel a 12 in. x 12 in. log, 18 ft. long, which brought the propeller to a dead stop and slowed the engine itself. The clutch slipped and smoked until the engine was stopped. The tug was taken to Kingston and the clutch dismantled. The discs were found to be blue, but when tried in the lathe for distortion were found to be running true. The fibre lining was also examined and checked for thickness, but there was no damage. The clutch was cleaned and assembled again and has continued in successful operation up to the present time. Propeller blades were slightly bent and were straightened.

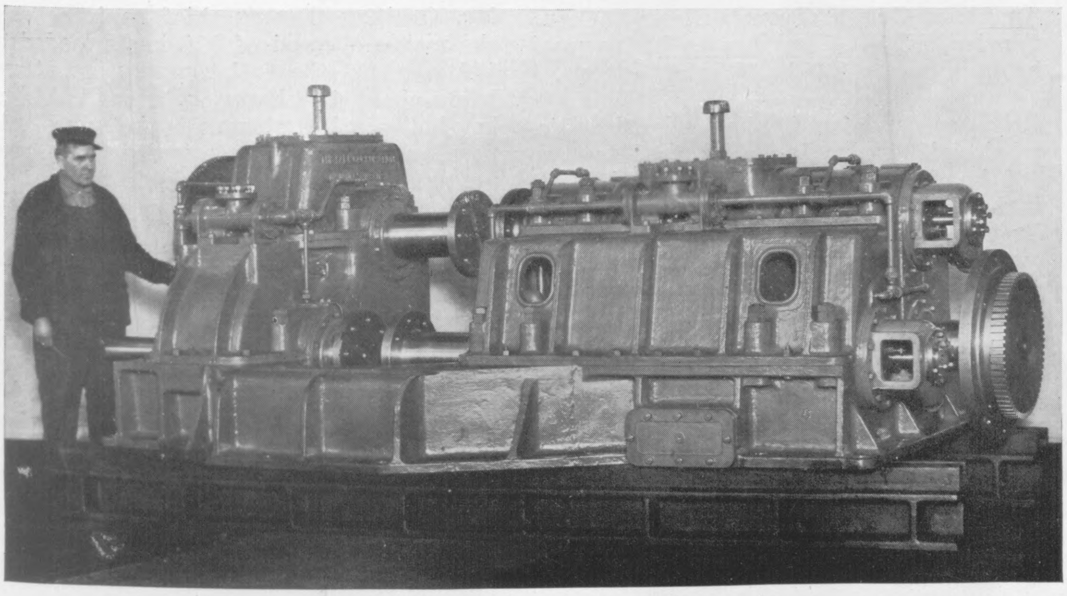
Maneuvering from full ahead to full astern can be carried out in $1\frac{1}{4}$ sec. In running at 12 knots the CORNELL'S headway can be checked and the vessel started astern in 40 sec. Reversing from full speed ahead has actually been carried out in the considerably shorter time of 25 sec.

The mechanical efficiency of the transmission is as high as $96\frac{1}{2}$ per cent. The CORNELL has been tested with regard to her pulling power against a direct connected Diesel engined tug of the same power. She registered a maximum pull of 12,400 lb. as against 10,400 lb. of the direct Diesel tug.

CORNELL has the following tank capacities for fresh water, fuel and lubricating oils:— Fresh water (100 per cent full) 312 gal.; fuel oil (93 per cent full) 5328 gal.; lubricating oil (100 per cent full) 528 gal.; hydraulic oil for clutch operation 390 gal.

The auxiliary machinery consists of a bilge pump and auxiliary air compressor driven by a 6 hp. Palmer gasoline engine. There are also a hand pump for pumping lubricating oil from the sump tank to the gravity tank, two starting air bottles, one whistle bottle, one spray air bottle, one gas engine driven generating set, one centrifugal lubricating oil purifier, a heating boiler and a lubrication oil cooler. The main engine drives from its own crankshaft the cooling water circulating pump and the lubricating oil pump, while belt-driven off the main shaft is the pump which supplies lubricating oil to the main gears, the pump supplying oil under pressure to the clutch system, a fire and bilge pump and a steering gear pump.

The steering gear is very compact. It is of the oil-pressure type. A pump maintains constant pressure in the system, and with the wheel at rest the whole system is in equilibrium. Putting the wheel over puts the system out of equilibrium and causes the ram to move until it is again in equilibrium. The ram itself controls the tiller through chains and is mounted 'thwartships in the stern overhang taking up negligible space.



Gear arrangement shows engine crankshaft higher above base line than propeller shaft

Motortanker for Light Oils

Powered by a 6-cylinder Gotaverken-B. & W. engine developing 2800 i.hp. at about 100 r.p.m. and designed principally for the carriage of light oils in bulk, the tanker BIANCA has been delivered to her owners Rederi A/S Damp. Oslo by Gotaverken Akt., Gothenburg, Sweden. A cargo of 8300 tons of oil in bulk is carried in 5 treble tanks, there being two centerline bulkheads —as is usual in ships designed to carry light oils—with the center tank in direct communication with the expansion trunk. No summer tanks are worked into the hull structure and the fore and aft gangway is arranged on the starboard side of the expansion trunk. The pump room with 2 cargo oil pumps having a total capacity of 400 tons per hour is arranged amidships. BIANCA has a length b.p. of 380 ft. 3 in., a beam molded of 55 ft. 0 in. and a load draft of 25 ft. 7 in.

The auxiliary machinery, in common with that of many motortankers, is part-steam and part-electrically driven. On her trial trip, BIANCA developed 3400 i.hp. at 113 r.p.m., the mean speed being 12.35 knots.

Bessemer Diesels of 800 b.hp. are being installed in the 171 ft. yacht SIVAD launched last month at the Tebo plant of the Todd Shipyards Corporation for D. P. Davis. These engines give the vessel a cruising speed of about 15 knots. SIVAD will have stateroom accommodation for 20 people and a crew of 25 officers and men.

Brodie Barge Line, now operating on the Mississippi River between St. Louis, St. Paul and Minneapolis, is being purchased by The Inland Waterway Corporation. Brodie fleet is being put into operation immediately on the river and the Corporation is offering shippers a dependable service in a small way this season. The equipment will be absorbed by the Corporation in the new fleet which it will lease from St. Paul and Minneapolis barge line promoters. The combined fleet will be ready for joint operations next April.

A recent catastrophe in the gasoline boat SAN MARCUS was responsible for the fitting of a Diesel engine in her successor. While the General Manager of the Standard Gypsum Company at San Marcus Island, Mexico, was preparing to leave for San Francisco, via Guaymas, a terrific explosion shook the island, and flying pieces of hull revealed the fact that the SAN MARCUS had exploded. A few moments beforehand this boat had been tied alongside the dock waiting to convey the General Manager across the Gulf of California to Guaymas. The exact cause of the explosion is not known, but this narrow escape, resulted in the purchase of another gas boat from which the gasoline engine was removed and a 75 horsepower Union Diesel engine was installed to insure safety of life and property and reduce the operating costs by burning Diesel fuel.

ELMER W. JONES, a new ferryboat, has been placed in service between Morristown, N. Y., and Brockville, Ontario, to replace the JAMES V. CRAWFORD which, after operating on this service last season was sold to Carl Fisher for use at Miami. The JAMES V. CRAWFORD, which was 100 ft. in length o.a. with a Nelseco engine of 180 b.hp., was sent through New York State Barge Canal before the close of navigation last year and loaded at Port Washington, L. I., with little speed boats which formed her cargo on the outside passage to Florida. (There was a rumor that no insurance could be obtained on her for that trip). The ELMER W. JONES measures 125 ft. o.a. and is engined with a 300 hp. Nelseco airless injection engine.

She was built throughout at the Groton plant of the New London Ship & Engine Co. to designs of Eads Johnson, naval architect. For delivery on the St. Lawrence River her deck structures were put in the hold, the low clearance under the canal bridges preventing her making the trip with the passenger accommodation and pilot house in place. The deck erections were completed after she reached Morristown.

Some operating data about the JAMES V. CRAWFORD and an announcement about the ordering of the ELMER W. JONES were given in Jan., 1926, MOTORSHIP.

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Readers are invited by the Editor to submit articles, photographs or drawings relating to motorships, marine oil-engines or auxiliaries. Contributions used in the magazine are paid for on the 15th of the title month of issue, and other contributions are returned as promptly as possible.

Bids have been called for by Southern Pacific Railroad on 3 to 5 Diesel-electric ferryboats each of 256 ft. length and of 1600 hp.

Bids have been called for by the Inland Waterways Corp., Washington, D. C., on three river towboats, 132 ft. long by 35 ft. beam.

Great Lakes Engineering Works, River Rouge, Mich., is reported to have ordered four 1000 hp. Diesels from the Busch-Sulzer plant for installation in a large dredge which will probably be built by the Manitowoc Shipbuilding Corp., Manitowoc, Wisc., for the Bucyrus Dredging Corp.

Thirty-three Coast Guard patrol boats, each 125 ft. long, are to be constructed by the American Brown Boveri Electric Corp., Camden, N. J. They are to be powered by twin screw 150 hp. Winton Diesels.

Delaware Dredging Co. has ordered a Diesel-electric dredge to be powered by two 400 hp. De La Vergne engines and Westinghouse electrical equipment. Hull and installation is to be supplied by the American Car & Foundry Co., Wilmington, Del. A second dredge of the same power will probably be ordered.

Atlantic Refining Co. has purchased from the Shipping Board the tankships SHARON, J. M. CONNELLY and BESSEMER, each of 7057 tons d.w. These are to be converted to Diesel-electric drive and will each have three 600 hp. Ingersoll-Rand engines with General Electric Company's generators furnishing power to a single propelling motor.

The order which the United States Bureau of Fisheries placed recently with Kruse & Banks, North Bend, Oregon, is for the construction of a boat to be used in Alaskan waters for patrolling the fishing grounds in that region. This boat is to be 100 ft. overall, 24 ft. beam and 11½ ft. depth. The engine ordered is a 225 horsepower, 6-cylinder direct reversible Union Diesel.

For Carl Fisher at Miami two Diesel-engined ferryboats are now building. One of these is a 125 ft. boat with a 300 hp. Nelseco airless injection engine, and the other will be 115 ft. o.a. with a 240 hp. Fairbanks-Morse engine, the first being a duplicate of the ELMER W. JONES just completed for the Morristown-Brockville service on the St. Lawrence, and the second being a duplicate of the YORK, placed in service last fall between Gloucester Point, Va., and Yorktown. Both are to the designs of Eads Johnson, naval architect, and the former has been entrusted to the New London Ship & Engine Co., while the latter is being built at Speddin's yard at Baltimore.

Bids are being asked by the Panama Canal authorities for supplying 4 Diesel engines and accessories for powering tugs for service in the Canal Zone. The hulls will be constructed by the Panama Canal at its own plant at the Canal Zone. The tugs are to be of Diesel-electric type and the Diesel engines are to be 6-cylinder units suitable for driving generators and exciters. They are to be of the high compression type with mechanical injection and are to develop 480 b.hp. each, the operating speed not being greater than 260 r. p. m.

FINN and FROST, motorships of the Svea Steamship Company of Stockholm, under charter to the General Steamship Corporation, have been put on a new service between Cuba and Gulf of Mexico and the Pacific Coast of North America running as far north as British Columbia.

This service was inaugurated in May by the M. S. FINN after discharging a cargo of sulphur from Galveston at Powell River and Vancouver, B. C., the FROST following in June. These are sister ships of 2745 tons d. w. built six years ago at the Finneboda yard in Stockholm. They are equipped with twin 500 s.hp. Polar Atlas Diesels which develop full power at 150 r. p. m. Mr. Orhberg, FINN'S chief engineer says she makes a speed of 9½ knots loaded at 140 r. p. m., the fuel consumption at sea being about 4.4 short tons a day. A donkey boiler raises steam for the winches in port, and steering at sea is done with compressed air. There is a single-cylinder, 4-cycle, 12 hp. Diesel engine running the electric lighting system; and a 2-cylinder, 4-cycle, 25 hp. Diesel engine operating the auxiliary compressor.

Centrifuges for purifying the fuel oil were installed two years ago. When the ship had been in commission about four years the fuel tanks were cleaned out following a lay up of some considerable time which had allowed the dirt to settle, and 40 tons of filth are said to have been removed after pumping the good oil from the top. The total capacity of the fuel tanks is 400 tons, and a fuel of 28 to 30 deg. Beaume is used.

New Diesel assembly plant has 468,280 sq. ft. floor area

New Diesel Assembly Plant

Constructed of steel and brick, Bessemer Gas Engine Co.'s recently completed assembly plant has 468,280 sq. ft. of floor area, without a stick of wood used any place in its construction. Two unobstructed parallel bays are joined by a connecting bay. The large west bay measures 65 ft. by 280 ft. by 44 ft. high, while the east bay is 56 ft. wide by 280 ft. long. The connecting bay is 30 ft. wide and runs the entire length of the building, but is lower than the two main sections.

The arrangement of material handling equipment in this structure absolutely eliminates hand handling. The large west bay is served with a 40 ton overhead electric travelling crane equipped with an auxiliary 7½ ton hoist for smaller loads, a series of 12 jib cranes and numerous small chain hoists. The east bay is equipped with a 15 ton overhead electric travelling crane, jib hoists and chain hoists.

Each of the four sides of the building is practically a solid expanse of glass, so that the building is flooded with daylight. There is only the thin steel sash to obstruct the light, and as a result the building is practically as light as the out of doors. It is so light inside the building that even on a cloudy day artificial lights are unnecessary, although a lighting system has been installed to take care of necessary night work.

The floors of the building are of asphalt block, in the form of bricks, laid on a heavy reinforced base of concrete. They absorb the shocks of heavy loads, are resilient yet wear-resisting and can be quickly patched without delaying production, endangering materials or hindering the workmen. Floor space is unobstructed, and except for the steel supports is utilized from wall to wall for productive work. The electric cables and water pipes are brought into the building through a tunnel which can be reached through removable traps in the floor. The exhaust pipes for the test blocks have also been built in an underground tunnel, so that when an engine or compressor is set up for test, there are no exposed exhaust or water pipes. The equipment to be tested is absolutely accessible to the testers.

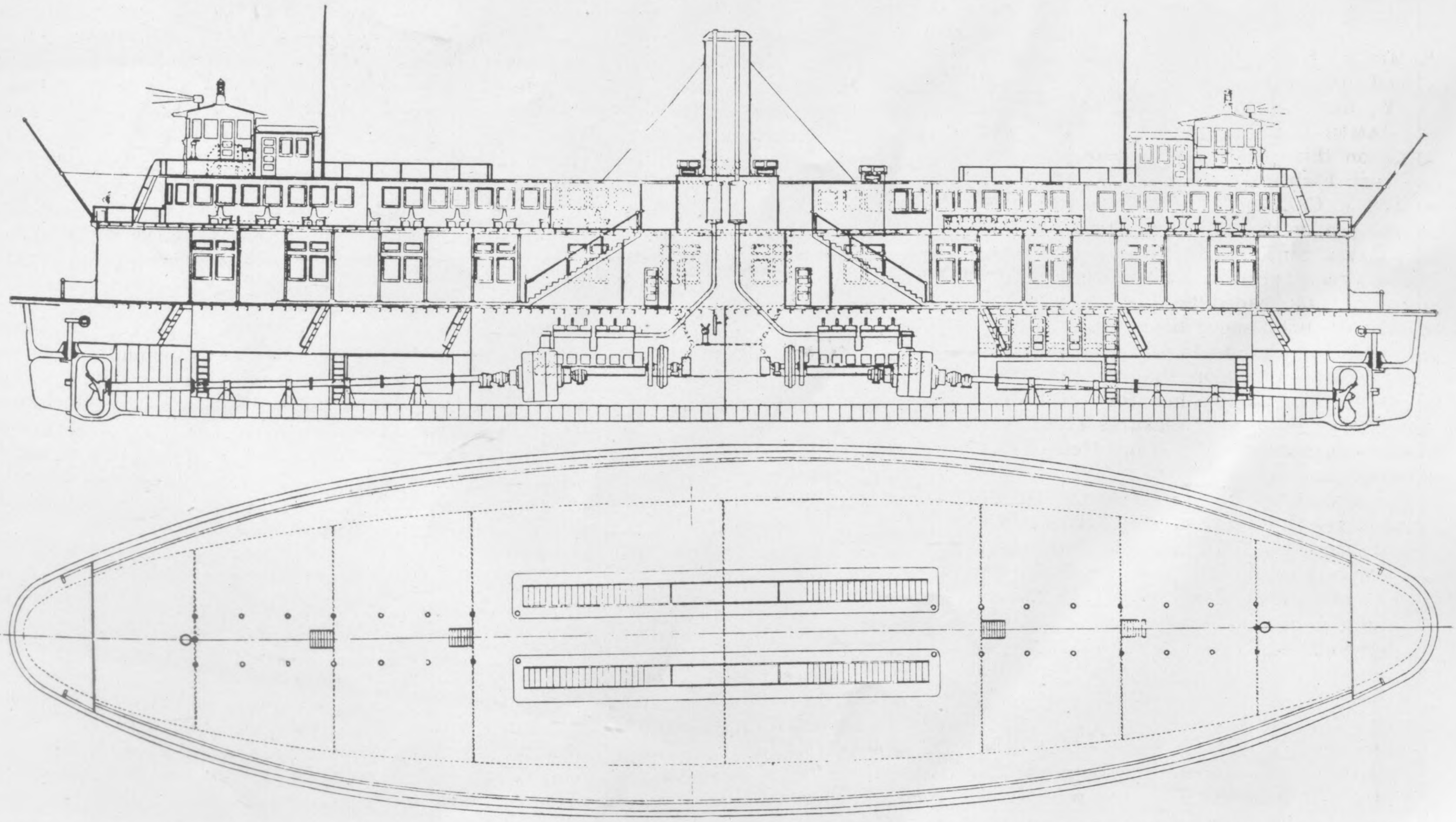
Southern Pacific Diesel Ferries

The initial attempt on the part of the Southern Pacific Company to use Diesel engines for ferry propulsion is marked by the fact that they have asked bids on 3 and 5 Diesel electric passenger and automobile ferries to be used in San Francisco Bay.

These boats will have the following characteristics:

Length o.a.	256 ft.	0 in.
Length b.p.	234 ft.	0 in.
Breadth, molded (hull)	44 ft.	10 in.
Breadth, molded (over guards)	61 ft.	3 in.
Depth, molded (guard side)	19 ft.	5½ in.

The plans call for four 400 b.hp. Diesel engines driving direct current generators and exciters for each boat. As the boats are to be of the double ended type, one propeller will be provided on each end and each propeller will be driven by one 1250 hp. motor.



Southern Pacific Railroad has asked bids for high class Diesel-electric ferryboats of 256 ft. length to be propelled by two 1250 hp. motors

New Double-Acting 4-Cycle Diesel

DEVELOPING 4000 b.hp. at 95 r.p.m. and with 6 cylinders $32\frac{1}{2}$ in. diameter by 59 in. stroke, a double-acting 4-cycle engine has been completed by the North Eastern Marine Engineering Co., Ltd., Wallsend-on-Tyne, England, for the motor freighter STENTOR building by the Caledon Shipbuilding Co., Dundee, Scotland, for Alfred Holt & Co., Liverpool. The design has been developed in conjunction with Werkspoor, Amsterdam, for whom the North Eastern Co. are principal British licensees, and contains many of the features associated with Werkspoor single-acting engines. Previous experience of a double-acting engine of this type has been gained from tests on a single cylinder engine ($31\frac{1}{2}$ in. diameter by 55 in. stroke) operated at Wallsend during the past two years, which has carried out during this time 4 non-stop runs of from 21 to 80 days duration.

The engine is of the double guide type and all the main running gear is supplied with lubricating oil under pressure. Main framing comprises cast iron "A" columns with long through bolts. The top cylinder heads are separate from the liners, the joint being just above the travel of the top piston ring. This permits of a new liner being fitted to an existing head. The liner is constructed in two parts with an expansion joint between the two, slightly open when the engine is cold but closed as it warms up. Compensating mechanism is fitted to the bottom fuel actuating gear to maintain constant fuel valve lift throughout the working temperature range of the cylinder. Top and bottom valves are readily interchangeable. Pistons are fresh water cooled, the water being conveyed to the piston through heavy gage telescopic pipes mounted on the astern guide shoes and passing up a $2\frac{1}{2}$ in. diameter hole in the center of the piston rod into the piston itself. The joint between the flanged head of the piston rod and the piston itself is tested to 1000 lb. per sq. in., so possibility of leakage is small. The fresh water cooler and lubricating oil cooler are both mounted on the engine columns.

As far as the top cylinder cover and its valves are concerned the new engine follows normal single-acting Werkspoor practice. Combustion on the bottom side is taken care of by an exterior combustion chamber bolted to the bottom cylinder cover side and containing the exhaust and air inlet valves arranged vertically, the starting air valve horizontally at one side and the fuel valve at an angle to the vertical, as is well shown in the illustration. The camshaft is at cylinder top level and this operates the valves for the bottom side of the piston by means of push rods.

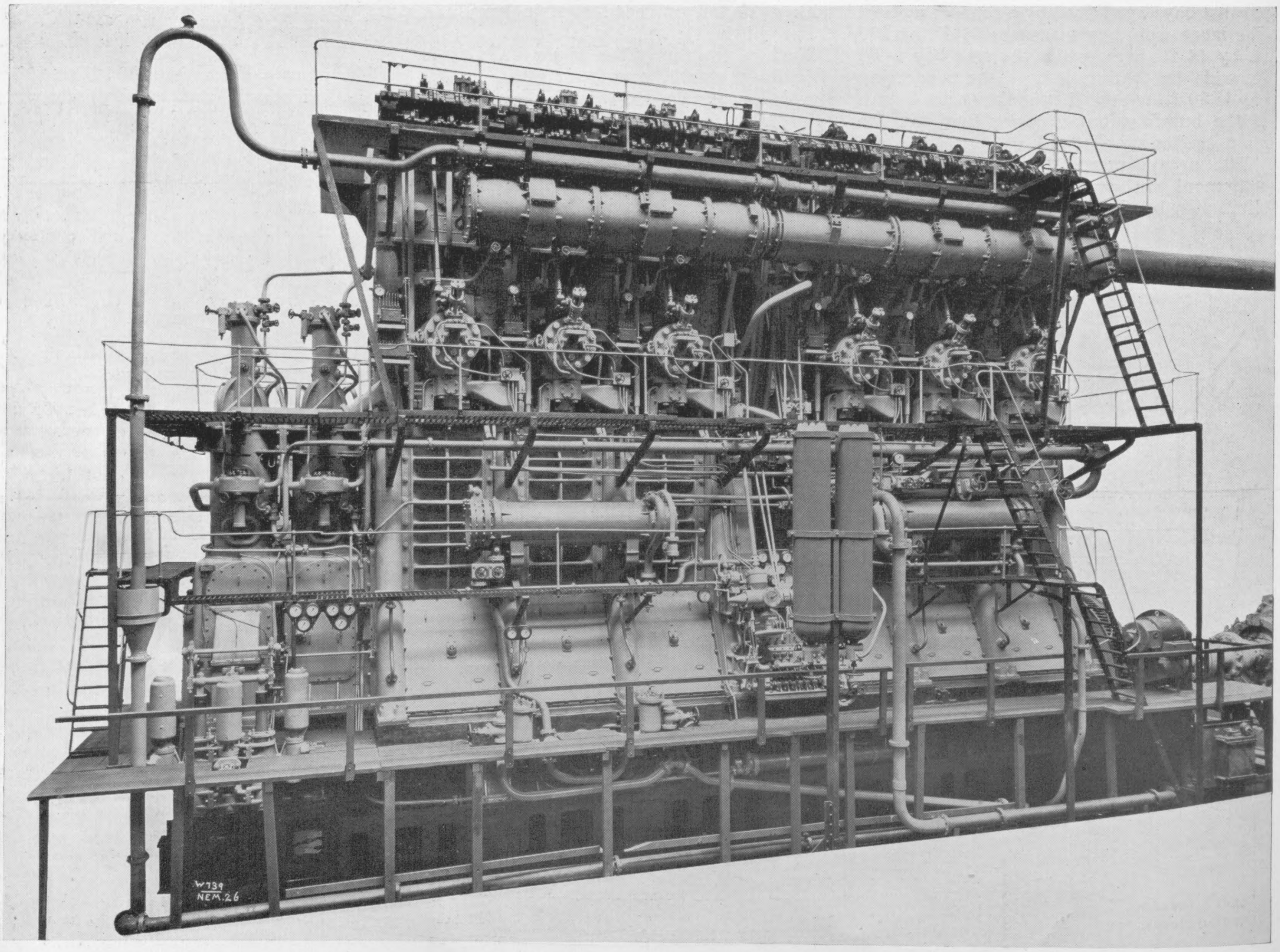
Reversal differs from arrangements adopted in previous engines of Werkspoor type, and is carried out by sliding the camshaft in a fore and aft direction. The top valve levers are mounted on eccentrics on the reversing shaft which also carries a scroll cam for sliding the camshaft.

The reversing shaft is rotated by means of a rack and pinion, the pinion being fitted to the shaft and the rack driven direct by an air cylinder in conjunction with an oil damping cylinder. The starting shaft is turned by means of a compressed air motor.

New "Still" Engine

Operating on the "Still" principle, a small single cylinder 130/150 b.hp. engine has been completed recently by Plenty Son & Co. Ltd., Newbury, England. On the combustion side the engine works on the 2-cycle principle with airless injection of fuel. On the underside of the piston it is virtually a steam engine with poppet type steam valves.

Compression pressure on the combustion side is moderate, being in the neighborhood of 350 lb. per sq. in. Mean indicated pressure is 76 lb. per sq. in. Cylinder diameter is about $14\frac{1}{2}$ in. and stroke $15\frac{1}{2}$ in. The engine develops its power at 250 r. p. m. and has a piston speed of about 750 ft. per min.



New double acting 4-cycle Diesel developed jointly by a well known British and a Dutch engineering firm develops 4000 b.hp. at 95 r.p.m.

Financial Notes

Westinghouse Electric & Manufacturing Co.

NET income available for dividends and other purposes for year ending March 31, 1926, was $14,122,001 or 11.9 per cent on the $118,530,150 total capital stocks. Dividends were paid amounting to $319,896 on preferred stock and on common stock $9,154,615. Sales during the year amounted to $166,006,800, and this, it is stated, represents the largest volume of business in the company's history, the highest previous annual figures being $158,000,000 in 1925 and $160,000,000 in 1919, the latter figure including, however, some non-electrical war business.

Sir W. G. Armstrong, Whitworth & Co.

Armstrong's results for 1925 showed a loss of $4,457,560. The previous year's working showed a profit of $2,526,255. A transfer of $4,500,000 from the general reserve fund was necessary in order to cover commitments and 5 directors have resigned from the board.

Stabilimento Tecnico Triestino

With a net profit for 1925 of $147,791, to which was added a carry forward of $19,038, a total of $166,829 was available for distribution. Of this, $9,250 was placed in the ordinary reserve fund and a dividend of 5 per cent, requiring $111,000 was paid to stockholders. Of the balance then remaining 10 per cent was paid to directors, $22,200 was assigned to stockholders as extra dividend and $19,800 carried forward. The plant is working at full capacity this year and expects to do so during the next few years. The report stated that work during 1925 was characterized by an increasing activity in the construction of new buildings and in the preparation of larger plant. (The lire is taken as worth 3.7 cents.)

Lloyd Triestino Soc. Anon.

Results for 1925 showed a net profit of $281,320, out of which $120,428 was paid as dividend to the common stockholders, $14,066 transferred to the reserve fund and $13,783 assigned to the Board of Directors as remuneration. After adding the 1924 carry forward to the remainder, a further dividend of $120,428 was paid to the stockholders and $19,610 carried forward to 1926. An increase of share capital from $3,740,000 to $5,610,000 was approved in addition to the issue of a loan for about $5,000,000 to take care of financial requirements resulting from increases in the company's fleet, foremost among which stands the order for two motorliners for express service between Trieste and Alexandria. The 1925 results showed a considerable improvement over those of the previous year and were a continuation of the improvement which has been made by the Lloyd Triestino during the past few years. The fleet including 122 ships including tugs, barges, etc., aggregating 208,623 tons gross stood on the books at about $353,093 to which must be added $486,200 for tonnage under construction.

Werkspoor, Amsterdam

Earnings from operations of the well known Dutch company were substantially the same in 1925 as in 1924. The annual report recently presented to the stockholders showed $600,036 gross operating in 1925 compared with $587,680 in the previous year. With the addition of $110,888 income from investments and a small carry-over from 1924 the profit and loss account showed a total credit of $718,767. After provision for depreciation, payroll tax, employees' sickness and accident insurance, shop and office pension funds, there was $326,064 net. A dividend of 6½ per cent (the same as last year) was paid on the A stock and 5¼ per cent on the B stock, and about $40,000 was invested. The reserve funds now amount to $781,850. Mr. Muysken, the president and general manager, reported that the industrial outlook had not improved, orders for locomotives and railroad cars have been scarce, but the Diesel engine works are busy. During the year some of the shops in Amsterdam were rebuilt and bigger crane capacity installed in order to cope with the increasing business in big marine Diesel motors.

International Mercantile Marine Company

Earnings of the International Mercantile Marine Company for 1925 showed a surplus of $923,029, after deducting all expenses, bond interest, and depreciation on steamers directly owned. This included dividends from subsidiary companies and from the operation of steamers directly owned, and was $782,308 less than the surplus for 1924. The consolidated result of operations of the parent company and its subsidiaries, the American Line, Red Star Line, White Star Line, Atlantic Transport Line, Panama-Pacific Line, and Leyland Line resulted in a deficit, after allowing for depreciation, amounting to $1,540,090 compared with a deficit of $1,079,304 in 1924. The actual operations of the company for 1925 resulted in a profit of $4,116,015 after deducting all expenses, taxes, and bond interest. Depreciation on the fleet amounting to $5,656,105 is charged against this profit which gives as a net result the $1,540,090 deficit mentioned.

Diesel Company's Affairs

F. H. Behneman, president of the Joshua Hendy Iron Works, is temporary receiver for the Diesel Engine Company, San Francisco. This appointment was made immediately after the filing of a suit by the General Machinery and Supply Company, to whom the Diesel Engine Company has for two years owed the sum of $4,349, asking that a receiver be named. Simultaneously, an answer was filed by the Diesel Company, in which it concurred in the application for a receiver, and asked an injunction against other creditors—250 in all—to prevent them from throwing it into bankruptcy.

The Diesel Company, a Nevada corporation with its principal office in San Francisco, has for two years owed General Machinery and Supply Company, a California corporation with head offices in San Francisco, the sum of $4,349, which it has been unable to pay. There are about 250 other creditors to whom is owed an aggregate of about $353,000.

The company is now filling a contract with the United States Shipping Board for twenty-two Diesel engines at a contract price of $751,723, of which $394,009 has already been paid. It also has other contracts aggregating $115,500, of which $65,000 has been paid.

Under the adminstration of a receiver, it was claimed that the company's affairs could be properly straightened out, to the benefit of both the company and the creditors. Bankruptcy, however, would entail general loss, because under a $150,000 mortgage on the Diesel Company's property, the physical assets would be sold at less than their value, resulting in a loss to all parties. Diesel Company is capitalized at $2,000,000.

Furness Operating Motorships to River Plate

Furness Withy has modernized its South American cargo services operating out of New York by the addition of the two 12 knot motor freighters CASTILIAN PRINCE and BRAZILIAN PRINCE, each of 5285 tons deadweight and 368,450 cu. ft. cargo capacity. BRAZILIAN PRINCE has now been in this service just over a year, while CASTILIAN PRINCE commences her second round trip to Buenos Aires on June 30th. These two ships were built in 1920 as TRAMORE and SYCAMORE for the Johnston Line Ltd., another Furness Withy subsidiary, for service between Liverpool and Mediterranean grain ports. Powered by Tosi 4-cycle engines of 3600 b.hp. built by Richardsons, Westgarth, Hartlepool, they were subjected to rigorous tests by an impartial body—the Marine Oil Engine Trials Committee—before going into service.

Their present work consists in carrying general cargo out of New York to Montevideo and Buenos Aires and returning via Rio de Janeiro, Santos, and Bahia with River Plate products, coffee and hides.

The South American trade is a busy one in which there is a good deal of competition to be faced from fast steamers as well as from motorships, and in view of this fact Furness Withy found it necessary to bring their Prince Line fleet on this service thoroughly up to date by the introduction of motor freighters. Kerr Lines Inc. now operates motorships of the Wilhelmsen Line, slightly larger and faster than the Prince Line ships, in this trade, while Garcia and Diaz have the motorships PRIMERO and SEGUNDO, as well as the chartered BORGESTAD and VINLAND running between New York and River Plate Ports.

SPRINGBANK a 5200 tons gross motor freighter for the Bank Line, managing owners for whom are Andrew Weir & Co., Ltd., London, has recently been handed over to her owners. She is powered by 2 sets of 6-cylinder Harland & Wolff-B. & W. engines and is one of the last of a group of 11 knot motor freighters built and engined by Harland & Wolff, Ltd., Belfast and Glasgow.

Psychology of Passenger Motorliner

Passenger Agents and Publicity Men Have in It a Potent New Appeal to the Traveling Public

MOTORLINER advertisements open up before the sister sciences of Diesel engineering and passenger ship construction a fresh vista, the vista of the ship operator and of the publicity agent. The attitude which these people display is that in the passenger motorliner they are offering to the traveling public the latest, the most wonderful and the most comfortable, or, in sum, a revolution in ship construction.

This is one of the most powerful magnets a company can wish for. The engineer appreciates the motorship in terms of fuel economy, low running costs, superior deadweight capacity, etc. The shipowner is aware of these facts, and as far as the cargo motorship is concerned is well pleased with them, but now that the large passenger motorship is coming rapidly into its own, he realizes he has an incomparable advertising appeal in the subtle fascination which something novel or different has for large sections of the traveling public.

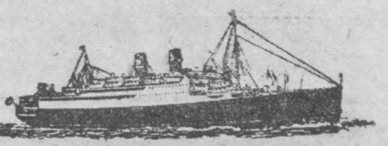
"The wonder ship." "Most luxurious motorliner in the world." The first phrase at once wraps a ring of romance around the prosaic double-acting 4-cycle engines of the ASTURIAS. "Most luxurious motorliner in the world" conjures up a host of other passenger liners also luxurious, but lacking the lure of motorliners. The passenger anxious for novelty feels at once that he must hasten his trip before these wonder ships become everyday vessels. In this way the shrewd publicity man fills the passenger list. Further, by making passengers feel that they are getting something extra he can ask them to pay higher rates, and they willingly pay.

"Steamless, smokeless, sootless, vibrationless": all of these attributes of the motorship subtly touch some little sore left by a recalcitrant steamship upon a passenger. In reading, he probably calls to mind leaky radiators in cabins, the clouds of filthy smuts which descend upon the boat decks of even the best managed steamer, the shaking from racing screws in a cabin over the stern. Thus he abandons himself to an orgy of imagination of the wonders which this new type of ship is to give him.

Far-seeing shipowners, as soon as engineers could definitely guarantee to them that the Diesel engine was reasonably reliable, placed orders for new passenger vessels to be motor-driven. Such shipowners know that the extra capital outlay will be handsomely rewarded.

"Motor" to Northern Europe in the new Motorship

"GRIPSHOLM"



The Only Passenger Motor Liner on the Atlantic

The fast and direct route to Sweden, with prompt and convenient connections for Norway, Denmark, Finland, Germany, Poland and the Baltic States, via the Swedish American Line's new Motorship "GRIPSHOLM" (first, second and third class) and splendid modern one-class Cabin Liners "DROTTNINGHOLM" and "STOCKHOLM."

The "GRIPSHOLM" is the last word in comfort and luxury. Steamless, smokeless, sootless, vibrationless—exquisitely decorated and furnished throughout—has magnificent swimming pool, gymnasiums, electric elevators, veranda cafe, suites and cabins de luxe, many staterooms with private baths, spacious open and sheltered deck promenades. All three of the Swedish American liners offer unexcelled service and absolutely unrivaled Scandinavian cuisine, the delight of all travelers.

PROPOSED SAILINGS FROM NEW YORK

Gripsholm	Apr. 29	Gripsholm	June 3	Gripsholm	July 3
Drottningholm	May 8	Drottningholm	June 10	Drottningholm	July 16
Stockholm	May 20	Stockholm	June 19	Stockholm	July 22

ATTRACTIVE RATES to Gothenburg, Malmo, Halsingborg, Oslo, Bergen, Copenhagen, etc.:

M. S. GRIPSHOLM, First Class, $195 up; Second Cabin, $152.50 up. S. S. DROTTNINGHOLM, Cabin, $152.50 up. S. S. STOCKHOLM, Cabin, $147.50 up.

TOURIST THIRD CABIN — SPECIAL LOW ROUND-TRIP RATES ($193 to $197) for Students, College Men and Women, Teachers and Business People, to Scandinavian points and return to America, sailing from New York as follows: June 19, S. S. Stockholm; July 3, M. S. Gripsholm; July 16, S. S. Drottningholm. Return from Gothenburg July 24, August 7, 14, or 28.

Special separate sleeping quarters with improved equipment, lounges, dining rooms and decks exclusively reserved for Tourist Third Cabin passengers. Write for programs and rates of our fascinating low-cost tours through Sweden, Norway and Denmark, arranged for Tourist Third Cabin passengers.

Booklet, "Scandinavian Tours 1926," and full information, from any tourist or steamship agency or

SWEDISH AMERICAN LINE, 21 State St., New York

Swedish American Line invites the passenger to "motor" to Europe on Gripsholm, last word in vibrationless comfort and luxury

The Second Great African Cruise

From New York, January 20, 1927

On the new Wonder-ship, The ASTURIAS, 35,390 tons displacement, most luxurious motor liner in the world. An alluring itinerary—to fascinating new lands and old favorite places—West Indies, South America, South and East Africa, Egypt and Europe.

The American Express Company is co-operating in the management of the African and Mediterranean cruises. Write for Illustrated Booklets.

ROYAL MAIL

"The Comfort Route"

THE ROYAL MAIL STEAM PACKET CO.

Sanderson & Son, Inc., *Agents*

26 Broadway, New York

Or Local Agents

Royal Mail Steam Packet Co. offers 35,390 tons displacement Asturias as a new wonder-ship, most luxurious motorliner in the world

Dieselization of the Pacific Ocean

More Than 15 Transportation Lines Are Operating Motorships in Regular Services to Port of Vancouver

INDICATION of the trend in shipping circles towards the general adoption of the motorship for runs to and across the Pacific Ocean is found in the large number of transportation companies now using motorships in their services to Vancouver, British Columbia.

The necessity for carrying economical fuel sufficient for long runs without seriously affecting the cargo capacity of a vessel and the saving in time effected by only bunkering once or twice for a trip equal to the distance around the world, is bringing motorships very largely into the regular freight transportation services between European ports and the Pacific Coast of North America, as well as on the long runs across the Pacific Ocean. The motor passenger liner has also shown, and indeed was the first to demonstrate its advantages in the Pacific Ocean service.

The reasons for so many motorships making the principal Pacific seaport of Canada their turning point are varied. Besides being a large exporter of lumber, fish and mineral products, Vancouver is the western outlet of wheat from the central provinces of the Dominion of Canada and also an important distributing center. It is also most northerly of big seaports on the Pacific Coast of North America.

Most of the lines from United Kingdom and European ports coming to the Pacific via Panama Canal make calls at Los Angeles, San Francisco, Portland and Seattle, as well as Vancouver; while the Japanese lines calling at Vancouver also visit Puget Sound ports.

Motorships now sail from Vancouver with cargoes for nearly every part of the world. The motor freight liners on the regular services are largely vessels of 12 to 14 knots speed, and 7000 to 14,000 tons d.w. capacity, while the motor passenger liner AORANGI on the Australasian run is an 18 knot ship.

The Royal Mail Steam Packet Co. and Holland-America Lines between them operate five 11,700 tons d.w. motorships on a regular schedule with general and refrigerated cargoes and a limited number of passengers from the United Kingdom and Continental ports to Vancouver, B. C., via Panama Canal, calling at all the principal ports on the Pacific Coast of North America.

A Furness Withy fleet including several motorships of about 10,000 tons d.w. also operates from British and Continental ports to Vancouver by the Panama route, carrying general and refrigerated cargoes and a few passengers, the PACIFIC SHIPPER being one of the well known motorships on this run.

East Asiatic Co. of Copenhagen maintains a regular service from Baltic Sea ports to Vancouver, some of the vessels being routed by Panama and others by the Far East. Needless to say these are all motorships on this run, mainly boats of 10,000 to 13,000 tons d.w.

Another pioneer of Diesel ships, the Johnson Line of Stockholm maintains a regular service from Scandinavian ports via Panama with such vessels as the ANNIE JOHNSON of 7200 tons d.w. with excellent passenger accommodation.

Cosmos Line motorships ISIS and OSIRIS come from German ports, also, by way of Panama, and the Norway-Pacific Line of Oslo, maintains a regular service from Norwegian and Baltic ports by Panama.

Isthmian Lines operate between United Kingdom ports and the Pacific coast, the motorship CHALLENGER being well known on this run.

A comparatively new service between Mediterranean ports and Vancouver is being maintained by the Navigazione Libera Triestina with the motorships LEME and FELLA, besides some other vessels; while new services have also been inaugurated with Cuba and South America. The General Steamship Corporation are operating the chartered motorships FINN and FROST on a run from Cuba and Gulf of Mexico ports to Vancouver; while the motorships TOSCA, INDRA, POLJANA and GEISHA owned by Winge & Co. of Oslo, have been placed on a new run between Vancouver and the west coast of South America.

Trade with the Orient is also feeling the influence of motorships, and the Nippon Yusen Kaisha which operates a large fleet of Japanese ships in Pacific trade has the modern motorships ATAGO MARU and ASUKA MARU on the run from Vancouver to Puget Sound ports; and Mitsui & Co., another large Japanese firm has the AKAGISAN MARU on this run.

The Australasian service of the Union S. S. Co. of New Zealand besides its steamers includes the motorliner AORANGI, operating between Vancouver, B. C., and Sydney, N. S. W., and the HARUAKI carrying freight in the same service, while they have also had the ENTON under charter.

In coastal service the Pacific S. S. Co. have the Admiral Line motorships BOOBYALLA and ADMIRAL PEARY on the California-Puget Sound freight service, also making Vancouver a port of call. The North is being served with motorvessels too.

The Northern Transportation Co.'s motorship NORCA comes in from Ketchikan, Alaska; while the Hudson Bay Co. is sending its auxiliary BAYMAUDE from Vancouver to the western Arctic this summer, and Capt. Carl Klinkenburg's Diesel schooner OLD MAID No. 2 and the new Diesel ketch NIGALIK are also leaving Vancouver to catch the opening of navigation in the western Arctic, on trading voyages.

Tramps are also operating on charter from Vancouver. Among those that have taken out cargoes this year are the motorships ELMBANK and ALYNBANK, owned by Andrew Weir & Co. under charter to the Canadian Trading Co. to carry cargoes to South Africa, and the motorships OAKWORTH, FERNDALE, THALATTA and others under charter to carry cargoes to various parts of the world.

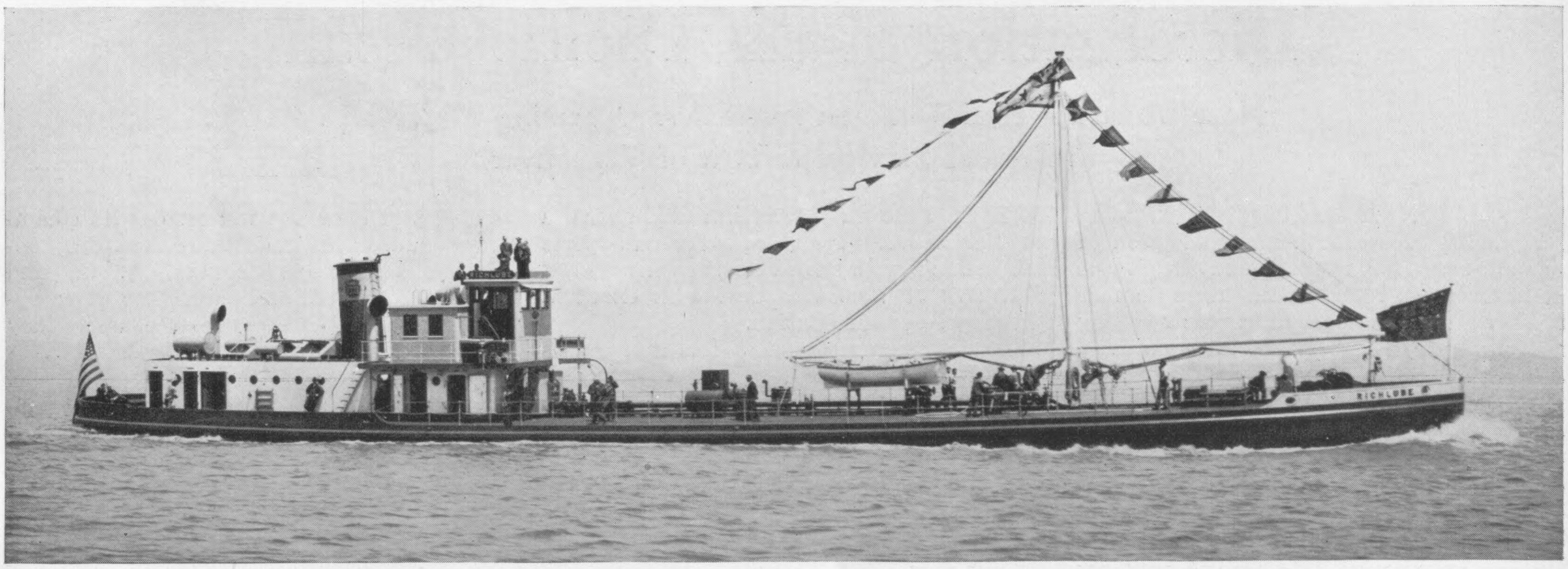
Nor does this imposing list include the motorships engaged in British Columbia coasting freight and passenger service; nor yet the industrious rum runners who have not overlooked this valuable form of power in their busy traffic.

New Norwegian Freight Motorship

BRYNJE, third motorship built for A/S Borgestad, Porsgrund, Norway, and sister vessel to the BORGESTAD which operated out of New York early this year under charter to Garcia and Diaz, was recently delivered to her owners by Burmeister & Wain Ltd., Copenhagen. She is of three island type with poop, long bridge deck—a hatch space larger than in the BORGESTAD—and forecastle, has a length b.p. of 350 ft. 0 in., gross tonnage of 3924, deadweight of 6800 tons, and a load draft of 23 ft. There are 4 holds, 3 forward of and one abaft the machinery space and these have steel centerline grain divisions, the total grain capacity being 345,000 cu. ft. BRYNJE is powered by two 6-cylinder B. & W. trunk piston engines rated collectively for 2200 i.hp. at 145 r.p.m. and has all-electric deck and engine room machinery. Garcia & Diaz inaugurated its South American service in February of last year with the chartered ms. VINLAND which was followed about the middle of March by the BORGESTAD, PRIMERO, and SEGUNDO, built specially for the service, went on service last year. All these vessels are of twin-screw type fitted with B. & W. trunk piston engines of approximately the same power.

"In 5 Years 'Time . . . ."

The fast motorship in 5 years' time will have run the steamer out of business on the South American trade, is of the opinion of A. V. Moore of Moore & McCormack, New York, who returned early last month from an extended tour of South American ports where he obtained first hand information of local trade conditions. He was impressed by the large number of foreign motorships of high speed at present operating in the South American trade from European and Japanese ports, as well as from United States ports, and he is convinced that this country must take up the fast motorship idea if it hopes to develop its merchant marine and place it on a level with those of other countries. Soon in some trades it will not be sufficient to own motorships; they must be fast motorships. His hope is that we shall be able to produce Diesels as economically as manufacturers abroad.



Diesel-electric propulsion has been adopted for Richlube, a 7000 bbl. shallow draft tanker for service on San Francisco Bay

San Francisco Bay Motortanker Activity

MOTORSHIPS are prominent among the shallow draft fleet employed to distribute fuel oil and its distillates to points in San Francisco Bay and neighboring, comparatively shallow, land-locked waters. Many interesting craft for such service have been delivered recently and more are under construction. For example, Associated Oil Company of California, has awarded recently to the Bethlehem Shipbuilding Corporation, San Francisco, a contract for the construction of a Diesel driven refined oil carrier for service on San Francisco Bay and on the Sacramento and San Joaquin Rivers.

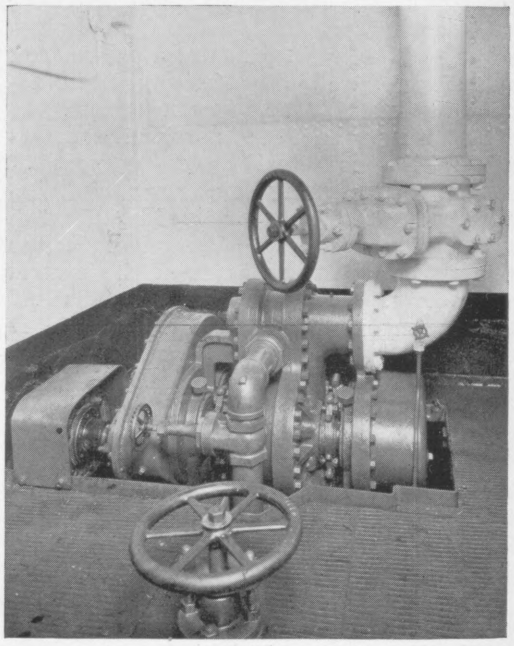
On account of the shallow water in these rivers at certain seasons of the year, it is necessary that the vessel be twin screw and of 6 ft. 2 in. normal loaded draft.

The new barge will have the following characteristics:

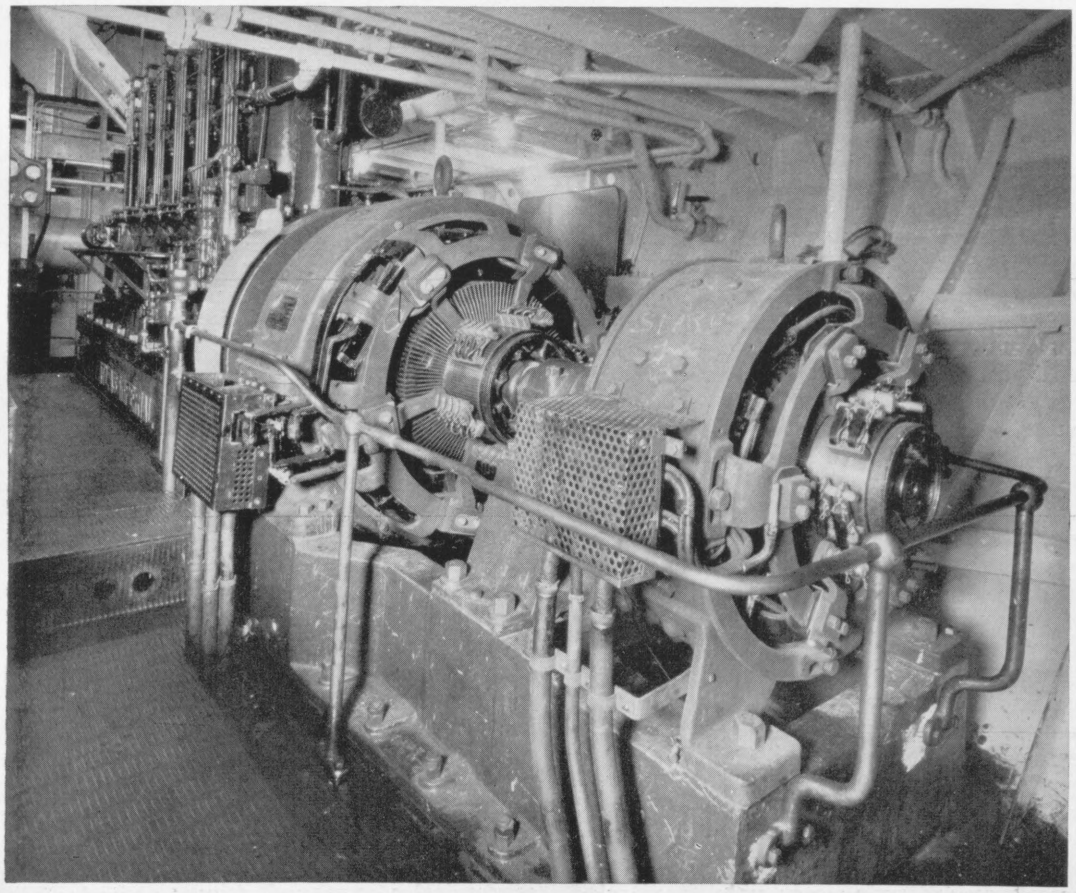
Length overall	166 ft. 0 in.
Breadth, molded	38 ft. 0 in.
Depth, molded	9 ft. 6 in.
Cargo capacity	3500 bbls.

The engine contract was awarded to the Union Gas Engine Co. of Oakland, California, who will deliver two 3-cylinder, 110 b.hp. Union Diesel engines. Cargo pumps will be of the Kinney type driven by Standard distillate engines.

MOTORMATES, a slightly smaller tanker, for the same owners and service went on service at the beginning of this year, while REDLINE, a 175 ft. tanker with package cargo accommodation in addition to her oil space was delivered to her owners' fleet during last summer.



Cargo oil pump



One of two 145 kw. generators supplying power to Richlube's 350 s.hp. propulsion motor

Among such ships recently completed is RICHLUBE, the Richfield Oil Co.'s motortanker described in June, 1926, MOTORSHIP, which satisfactorily completed her trials May 10 and was handed over to her owners. RICHLUBE has a 7000 bbl. tank capacity and is powered by two 6-cylinder, 250 b.hp. Atlas-Imperial Diesels which are direct connected with two 145 kw., 250 volt Westinghouse d.c. generators and 20 kw. Westinghouse exciters. Main propelling motor is of Westinghouse double armature type of 350 s.hp. at 160 r.p.m.

Richlube Average Trial Data

Speed of vessel	8.9 knots
Revolutions of main motor	175 r.p.m.
Amperes, main motor	580 amps.
Volts, main motor	248 volts
Revolutions starboard engine	280 r.p.m.
Revolutions port engine	282 r.p.m.
Power developed by starboard engine	200 b.hp.
Power developed by port engine	200 b.hp.

The vessel was constructed at the Potrero plant of the Bethlehem Shipbuilding Corp. and is practically identical with GENERAL, a 6000 bbl. tanker built by Bethlehem last year for General Petroleum Corp. GENERAL was described in detail in February, 1926, MOTORSHIP.

Towboat Fleets Using Radio Telephony

Show Gain in Operating Efficiency Accompanied by Increased Mobility and Reduced Running Costs

SPEEDY shore-ship and ship-shore communication is one of the advantages which the installation of radio telephony sets permits of in small craft like towboats, fireboats, and tenders operating a 24-hour schedule in harbors, sounds, bays and estuaries. Endless time is saved when the tug operator acting almost as a train starter can talk directly with skippers and send them straight from one job to another. Radio telephony is one of the scientific refinements which progressive owners are working into new designs in many cases in conjunction with Diesel engines.

Improvements of this nature are shortly to be introduced in a tug fleet operating in New York Harbor, while an outstanding feature of marine activity on the British Columbia coast during the past twelve months has been the adoption of radio telephone communication between towboats and shore stations.

This system is in operation over the whole area of inside waters between Vancouver Island and the mainland of British Columbia from the Juan de Fuca Strait in the south to Queen Charlotte Sound in the north. The work is carried on through three special government operated land stations, two of which are on regular duty at one time to act as clearing stations for radio telephone messages. Fifteen towboats have already been equipped with transmitting sets, and orders have been placed for more than 10 additional sets and about the same number for fishing craft, besides sets for other boats such as a hospital motorship, and a dredge. Shore stations at logging camps, mills and other industrial points scattered along the coast are being installed almost as fast as the sets are available.

The Wallace Fisheries is equipping several of its seine boats, former steam whalers, with this system of communication, and is also establishing a shore station at its plant on Kyuquot Sound on the west coast of Vancouver Island. The Canadian Packing Co. with a cannery at Esperanza Inlet is putting in a shore station there, and also equipping a number of fishing craft with radio telephone sets. These seine boats and fish carriers are principally vessels of 85 feet overall and about 18 ft. beam equipped with 110 b.hp. Diesels.

Towboats with this equipment have found it very valuable for communicating weather conditions to each other, besides keeping owners posted on their movements and receiving orders when away from port.

The first towboat set was installed in June 1925 in the tug COUTLI of the Blue Band Navigation Co.'s fleet at Vancouver, B. C., and by November of that year this company had five of its fleet equipped with radio telephone sets. Of these boats the tug PROSPERATIVE has a 6-cylinder 200 hp. Winton Diesel engine, and the PROSPECTIVE No. 2, a 6-cylinder 360 hp. Fairbanks-Morse Diesel engine, both of these boats having been converted from steam power in the last year or two; so that it is evident that the adoption of the radio telephone system was quite in keeping with the progressive spirit shown by this company.

Large Vancouver towboat fleet has Diesel units, radiophone operated

A good deal of credit for taking the initiative with regard to the equipping of commercial tugs with radio telephone is due to Mr. C. S. Thicke of the Blue Band Navigation Co. This system has been used for some time for short distance communication between naval craft; while on shore the broadcasting of news and entertainment has been developed to such an extent that it does not require more than passing mention. Also the ordinary use of wireless telegraphy at sea and on shore has become almost one of the necessities of life. Wireless telegraphy is in use on many large tugs at the present day, but requires the carrying of a specially qualified operator.

A system of radio telephone communication was put into operation as long ago as six years by the Forest Branch of the Canadian Department of Lands to keep in touch with the fire rangers' launches of the Canadian Government Forestry Service in the Vancouver forest district on the British Columbia coast. This covered the inside passages between Vancouver Island and the mainland of British Columbia, a distance of about 250 miles along the coast.

The Forestry Service installed Marconi radio telephones, the sets on the launches having a range of about 40 miles, and the shore stations about 70 miles. Their largest boat that has a set is the 60 ft. Diesel engined cruiser B. C. FORESTER, the other boats being smaller gasoline launches. While there are 3 shore stations, one at the District Forester's headquarters in Vancouver, one at Myrtle Point on Malaspina Strait, and the other at Thurston Bay on Johnson Strait, nearly all the work with the fire rangers launches is done from the two latter stations. Communication between the shore stations is usually carried on by Morse code, using continuous wave transmission, for which these sets are adapted as well as for speech transmission. The shore stations work with the boats on a wave of 300 meters.

Government shore stations were established to keep in communication with the tugs by the Radio Branch of the Canadian Department of Marine and Fisheries, which installed Northern Electric wireless telephone sets of about the same range as those fitted in the towboats. These sets work on a 200 meter wave and cover the area of inside waters between Vancouver Island and the mainland of British Columbia from the Strait of Juan de Fuca to Queen Charlotte Sound. These stations have been established at Vancouver, B. C., at Merry Island on the Gulf of Georgia, and at Alert Bay on the inside passage near the north end of Vancouver Island, so that they cover much the same ground as the Forestry radio telephone system. The toll charge for messages is 12 cents a word, of which 4 cents is remitted to the boat. The Merry Island and Alert Bay stations are used almost exclusively for clearing stations for messages to the tugs, and some very good results are reported. The Marpole Towing Co.'s tug R. F. M. of Vancouver was in radio telephone communication with Merry Island station from Seattle, Wash., 165 miles away. Messages were exchanged at 10 o'clock in the morning, and the reception was said to be quite clear. This tug was also in communication with Merry Island from Point No Point and Point Wilson in Puget Sound, speech at the latter point being good on the loudspeaker.

Mr. C. S. Thicke, manager of the Blue Band Navigation Co., at first had a receiving set at his office on the Burrard Inlet waterfront, but found there was too much interference there for good reception, so moved it out to his home at Point Grey, where he gets very good results, and is frequently able to learn where the tugs are by listening to them communicating with each other. He states that he has heard messages from the tugs when they were as far distant from Vancouver as Anacortes, Wash., Comox, Vancouver Island, and Powell River at the north end of Malaspina Strait. There are still a few "dead" spots between the mountain walls of some of the long inlets, and other places where radio broadcasts gets strangely silent, while messages sent a mile or two away are clear.

Sketches and Working of Oil Engines*

Circle Diagrams Aid Study of Reversing Systems—Analysis of Mechanisms Found in Practice

REVERSING of marine Diesel engines is not a difficult matter to grasp providing the student succeeds in holding to just this one underlying idea: Whether going ahead or astern, the same order of valve events must be preserved.

In a 2-cycle engine, for instance, the exhaust ports, being higher than the inlet openings, will always be uncovered first as the piston travels downward. Hence the reversal of a 2-cycle engine requires only a slight shift of the fuel and starting valve timing, the exhaust and admission events always occuring in proper sequence no matter which the direction of rotation of the crankshaft may be.

For a proper understanding of 4-cycle engine reversal it is important to remember the following sequence of valve events, which must always be maintained irrespective of the direction in which the cranks may be rotating:

Fuel injection (or Starting)
Exhaust
Admission

In all practically applied valve gears there is a rigid drive between the crankshaft and camshaft, so that a reversal of the one automatically reverses the other. The real problem of reversing an engine therefore consists in preventing the backward-moving camshaft from inverting the correct and unchangeable valve sequence. On the other hand, reversal may be defined as the process of inverting the rotation of the cranks while keeping the valve sequence intact.

Schemes have been proposed, but never commercially applied, for reversing the rotation of the camshaft with respect to the crankshaft, that is, for keeping the direction of the camshaft motion uniform for both ahead and astern running. One of the reasons why such arrangements have failed is that they require the camshaft drive to be disconnected momentarily. Obviously it would be impossible to have both the ahead and the astern drive in gear at the same time without running the risk that the least idle motion, or "rocking" of the engine against compression, would break something. Hence during some part of the process there would have to be an appreciable period of time in which the camshaft was entirely free of the crankshaft, after which it would be necessary to re-engage the two shafts in proper register for astern running. To obtain this, either the crankshaft or the camshaft would have to be barred over—an operation impossible for the rapid maneuvers required in marine work. Troubles arising out of the change in the firing order of the cylinders also contribute their share towards dooming the uni-directional camshaft.

To facilitate the study of valve timing and reversal, Dr. Julius Magg† has devised an unusually simple diagram of the circle type, recalling strongly the Zeuner diagram used for steam engines. In contrast with the latter, however, it is far easier to understand and apply.

The Magg diagram is based on an elementary proposition in geometry far easier to understand than the harmonic ovals occurring in the Zeuner diagram. It goes directly to the heart of all 4-cycle valve gear problems by providing an arrangement of circles which automatically reproduces the 2:1 relation between the crankshaft and camshaft motion.

In 4-cycle engines the crankpin center describes two complete circles while a point on

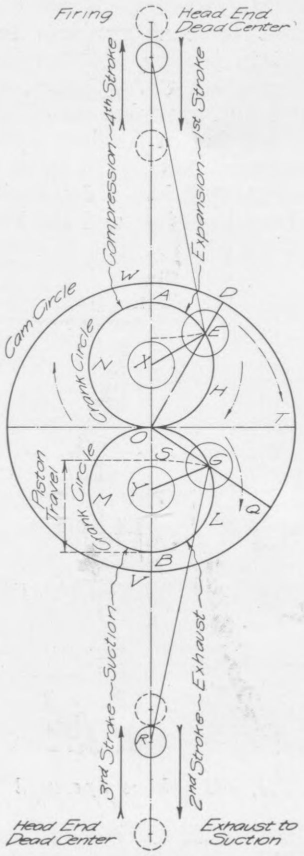


Fig. 150. Principle of Magg circle diagram

the camshaft surface describes one circle. Let the two crank circles, H and L, fig. 150, be drawn tangent to one another with centers X and Y while a centerline A-B is drawn through the two centers. Elementary geometry proves that this centerline, designated as A-B, must also pass through the point of tangency O. Now let the circle C, having any convenient radius OD, be drawn with the tangency point O as a center.

In such a diagram the outer point A may be taken to represent the head end dead center. Now as the engine crank X-E turns downward with X as a center; it will reach the bottom dead center O after traversing 180 deg. At this moment let it be assumed that the crank center shifts to the point Y and that in coming back to the top dead center B the crank arm passes along the 180 deg. circular arc OGB. B is therefore the same head-end dead center as A, so far as its location in space is concerned, but it is a different head-end center with respect to time because of the very important fact that it is reached 360 deg. after firing has taken place. Although the piston has again returned to the same point in space, the processes it is now undergoing are radically different from those which occurred during its previous visit there. No combustion is taking place and all pressure in the cylinder is relieved because the exhaust valve is still slightly open while the inlet valve has just begun to lift. Hence the diagram immediately provides a convenient and positive way of distinguishing between the two different kinds of head-end dead centers occurring in the 4-stroke cycle.

The complete key to the diagram now becomes:

1. Expansion: Arc AEO, Crank center at X
2. Exhaust: Arc OGB, Crank center at Y
3. Suction: Arc BMO, Crank center at Y
4. Compression: Arc ONA, Crank center at X

A little practice quickly overcomes the difficulty of shifting back and forth between the two centers X and Y, likewise that of having the exhaust and suction crank arcs OLB and BMO inverted. Although the crank centers appear to travel downward along the exhaust arc OLB and upward along the suction arc BMO, a little reflection will show that the opposite is really the case.

Let OD represent any reference line on the camshaft, say a radius scribed on the end of the shaft where it protrudes slightly from its last bearing. The mark might of course equally well be a center-punch burr on the camshaft gear, or a line scribed across the face of one of the cams.

From the point E, where OD intersects the crank circle H, let the crank-arm F be drawn to the center X. No matter where this construction may be carried out, it will be found that the angle AE represents crank travel while the angle WD correctly represents camshaft travel. If this is really the case, then the angle AE must always be twice as great as WD, because the crankshaft travels twice as far as the camshaft in a given interval of time.

Proof: Triangle XEO is isosceles because its two sides, XO and XE, being radii of the same circle, are equal. Hence the angles XEO and XOE are equal. These two angles, plus the third angle EXO of the isosceles triangle together equal 180 deg. Also the same angle EXO plus the angle AXE together equal 180 deg. Subtracting the common angle EXO from the two members of this equality, it is found that the two remainders, namely (XEO +XOE), and AXE must also be equal. Since XEO and XOE have already been shown to be equal, their sum may be replaced by $2XOE$. From this it follows that $2XOE$, or twice the camshaft angle, equals AXE, the crankshaft angle. Q.E.D.

The proof may be repeated in a similar way for the remaining three semi-circles occurring in the diagram.

It is a peculiar and useful property of the diagram that the crank radii XE and YG, although apparently making a sudden jump between X and Y at the bottom dead center really travel uniformly and continuously in double proportion to the motion of the cam radius OD or OQ, which both have an unchanging center at O. Thus if EXA, the crank angle, is 60 deg., EOX, the cam angle, will be found to be 30 deg. Also if the crank travels 68 deg. (equal to angle GYO) after passing the bottom dead center O, the corresponding cam angle TOQ will measure 34. Similarly the cam travel WOQ will be found equal to ½ (180+TOQ) deg., notwithstanding the fact that the crank center has been shifted from X to Y during this interval.

Note that the angle XOE of the camshaft is always the same, no matter what radius OD may be chosen for the camshaft circle. This fact is often made use of by designers engaged in laying out cam diagrams, after having spotted the head-end dead center on their cam

* Summary of a Course of Instruction at the Polytechnic Institute of Brooklyn, N. Y., by Julius Kuttner, B.Sc., Licensed Chief Engineer, Editor of OIL ENGINE POWER and Associate Editor of MOTORSHIP. This is the fifteenth chapter, the first one having appeared in the January, 1925, issue.

† Die Steuerungen der Verbrennungskraftmaschinen (Valve Gears of Internal Combustion Engines), published by Julius Springer, **Berlin.**

drawing, they use it as the centerline for the two crank circles *AEO* and *OGB*, choosing their radius to any convenient scale having no reference to the scale of the cam circle.

Although oil engine valve timing is almost wholly determined with reference to cam and crank angles, piston positions and percentages of stroke may also be conveniently investigated by means of the Magg circles. For instance, in order to find the piston position corresponding to the point *G*, it is merely necessary to strike an arc *GS* from a center *R* on the centerline *WV* extended using the connecting-rod length *GR* as a radius. The point *S* thus found on the centerline of piston motion shows that the piston has traveled the distance *OS* from the bottom dead center *O*

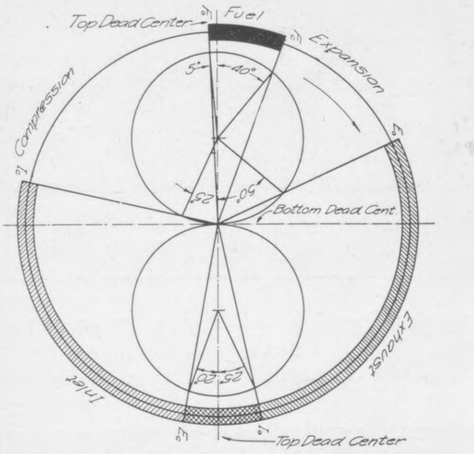


Fig. 151. *Circle diagram of 4-stroke cycle*

and is situated at a distance *SB* from the top dead center *B*.

The application of a circle diagram like this to a representative example of oil engine timing is illustrated in Fig. 151, on which the various valve events and the duration of openings has been plainly marked. Although it would also have been possible to include in this diagram the connecting-rod arcs defining piston positions for the various valve events, they have been omitted partly for the sake of clearness and partly because of the fact, already noted, that piston stroke percentages do not cut nearly the figure in oil engine timing that they do in steam engine valve gear studies. A table forming a key to the diagram of Fig. 151 is attached herewith: stroke percentages are included in it for the sake of interest.

when the inlet valve seats. Realizing this fact Dr. Diesel conceived his first engine with only a single valve held open substantially for the entire 435 deg., period above referred to. In this machine the piston was to approach the upper dead center while driving spent gases out through the single valve and after having reversed its travel at the upper dead center was to draw in fresh air through the same valve still held open. Naturally that

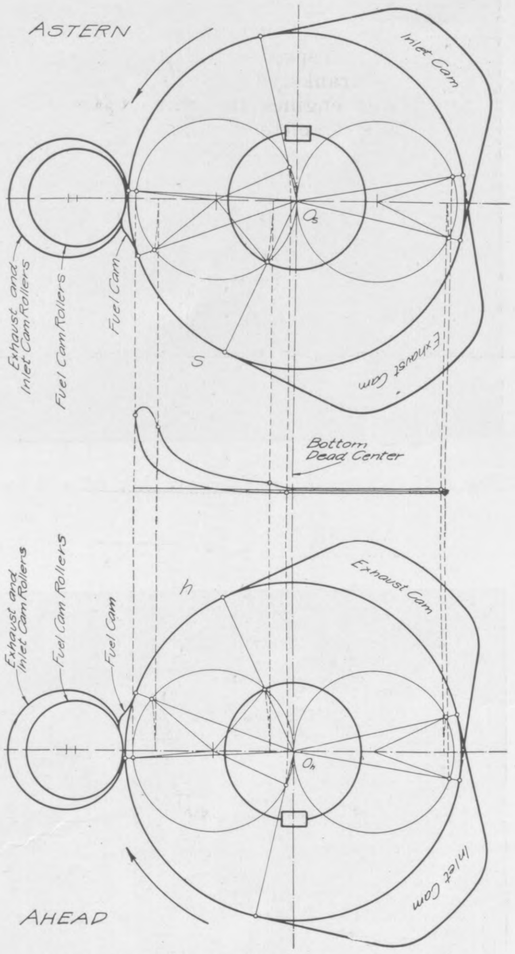


Fig. 152. *Circle diagram of reversing*

arrangement precluded the use of an exhaust pipe or suction elbow, because the waste gases remaining in it after the piston had passed the upper dead center would be reversed and drawn in on the suction stroke. However, the idea had the merit of permitting easy re-

KEY TO DIAGRAM, FIG. 151.

VALVE EVENT	SYMBOL	CRANKANGLE	TOTAL OPENING	PER CENT STROKE
Fuel Valve Opens	F_o	+ 5* Deg.	45 Deg.	0.25
Fuel Valves Closes	F_c	—40 Deg.		
Exhaust Valve Opens	E_o	+50* Deg.	250 Deg.	15.0
Exhaust Valve Closes	E_c	—20 Deg.		4.0
Inlet Valve Opens	I_o	+25* Deg.	230 Deg.	6.0
Inlet Valve Closes	I_c	—25 Deg.		2.0

* Plus sign indicates valve event occurring before dead center from which it is measured; minus sign indicates event occurring after the dead center.

The lack of symmetry and regularity which characterizes 4-cycle valve timing may be clearly visualized with the help of Fig. 151. It tells why most designers have given up as a bad job every attempt to utilize the same set of cams both for ahead and astern running.

Noteworthy is the circumstance that out of every 720 deg. of crank travel only 285 deg. are traversed with inlet and exhaust valves shut and are available for the real business of the Diesel cycle—compressing and expanding. The remaining 435 deg. are devoted to low-pressure transfer processes such as exhausting spent gases or drawing in a fresh charge of air.

As a matter of fact the 4-cycle Diesel cylinder is open to the atmosphere from the moment when the exhaust valve lifts up to the time

versal of the engine, because, as will be seen from Fig. 151, the crank of a single-valve engine could just as well travel from F_o to I_c during expansion as from F_o (slightly shifted by a simple gear) to E_o, so long as there was no difference between inlet and exhaust. However, the obvious necessity of leading the exhaust away in a separate passage compels the use of individual exhaust and inlet valves on the great majority of modern designs, of which the diagram in Fig. 151 is a good average representation.

If the engine for which Fig. 151 is drawn were to be rotated backward without the reversing arrangements about to be considered, it might conceivably be made to run in the astern direction, about as follows: The fuel valve would open with an excessive lead of 40 deg. and would ordinarily produce a heavy pre-ignition, an experience actually encountered on submarine engines fitted both with air reversing systems and with means for starting astern by the aid of an electric motor on the propeller shaft. Having survived the preignition the piston would travel downwards until the inlet valve would open at I_c, discharging the exhaust into the engine room. At the second dead center the exhaust valve would open at E_c, permitting air or spent gases to be drawn into the engine from the exhaust manifold. Compression would begin at the point of exhaust valve closure E_o.

These assumed absurdities illustrate better than anything else why the standard modern method of reversing a 4-cycle engine depends on the use of separate and distinct cams for ahead and astern running. The latter are reversed duplicates of the ahead cams and may be regarded as the valve gear for a special astern engine capable of being thrown into action in place of the ahead engine normally used. This hypothetical conception is not im-

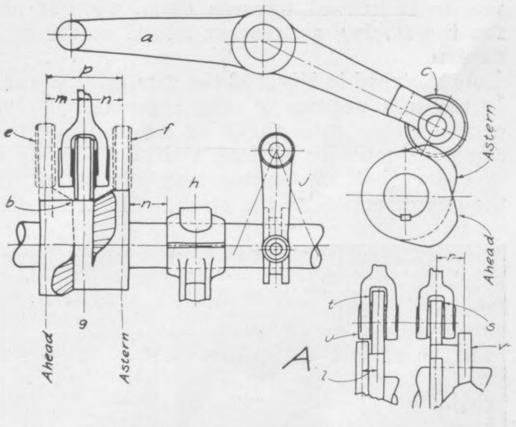


Fig. 153. *Bevel-flank reversing cams*

paired by the fact that the astern cams are, as a matter of fact, applied to the same pistons and engine structure as those used for ahead running and it emphasizes the principle that for the purposes of reversal the engine is temporarily transformed into an astern machine. That is the fundamental point of similarity between oil engine and steam engine reversing systems. In the latter the link motion substitutes an astern eccentric for an ahead eccentric, momentarily rebuilding the "ahead steam engine" into an "astern steam engine."

So the modern 4-cycle oil engine reverse gear substitutes astern cams for ahead cams or vice versa. Whichever set of cams happens to be in engagement, it producers the same sequence of events as that which is found by tracing the diagram of Fig. 151 in the direction of the arrow.

Postponing for a paragraph or two a study of the mechanical gear by which the substitution is accomplished, an inspection of Fig. 152 furnishes the clew as to how the appropriate interchange of astern and ahead cams prevents the reversal of the engine from altering the proper valve sequence.

The two cam groups shown would represent actual end views of camshaft assemblies; but in the interest of clearness the ahead cams have been separated from the astern ones despite the fact that they are keyed side by side on one and the same camshaft. In some of the earliest reversing systems ever devised two entirely distinct camshafts, both driven at half-speed from a common source, were used, and the act of reversal consisted in sliding them parallel to themselves without uncoupling them from the drive, until either one or the other of them was in position under the cam roller centerlines.

In Fig. 152 the circles *h* and *s* represent the cam base circles and at the same time form the outer Magg circle with centers at the tangency point O_h and O_s between the two

lightly-drawn smaller circles representing crank travel. Valve events marked by radii of the outer Magg circles h and s fittingly coincide with changes in the cam contours corresponding to them. In following the diagrams through it will be found simplest to consider the cam rollers as revolving about the camshaft, even though the reverse is actually true.

The fact that it is possible to use one and the same indicator diagram (at the center of the figure) for identifying all the events is a striking illustration of the principle that reversal preserves the proper valve sequence intact.

As already pointed out, all the mechanical arrangements for realizing the principle of Fig. 152 depend upon the bodily interchange of two entirely distinct sets of cams. One of the simplest ways of accomplishing this consists in the use of bevel-flank cams sketched in Fig. 153. Here the camshaft is manually shifted endwise by means of a level collar j. As there is no provision for lifting the rollers clear of their cams, some of them would be sure to lock those cams whose projecting portions happen to be turned towards them, were it not for the sloping approaches milled at the cam flanks.

As sketched in Fig. 153 the cam roller stands in the mid position g. In order to put the engine either into ahead or astern gear the camshaft must be shifted a distance m or n in order that the engine may run either in the one direction or the other. The total distance p through which the camshaft must be shifted is considerable and places a decided limitation on the effective wearing width of the cam and roller faces. It is to be borne in mind, moreover, that the total center distance between any two adjacent cylinders must be apportioned among one camshaft bearing and eight cam hubs, plus eight slope lengths b (exhaust, inlet, fuel, and starting valves and the astern duplicates of each), plus a travel equal to $2n$ or p. This reduces the effective cam width to so narrow a face that the arrangement is limited in its application to engines of small capacity. The forces exerted by the cams of larger engines are too great to permit of their being successfully accommodated by the bevel-flank arrangement.

In 4-cycle engines of a grown-up size it is therefore quite universal to find that the ahead and astern cams have no bevel flanks and are spaced as close together as it is in any way possible to get them. Fouling the rollers by the cam noses while sidewise shifting is in progress is prevented in the great majority of cases by withdrawing all the rollers beyond a clearance circle described with the camshaft axis as a center and the distance to the extreme cam tip as a radius. When that has

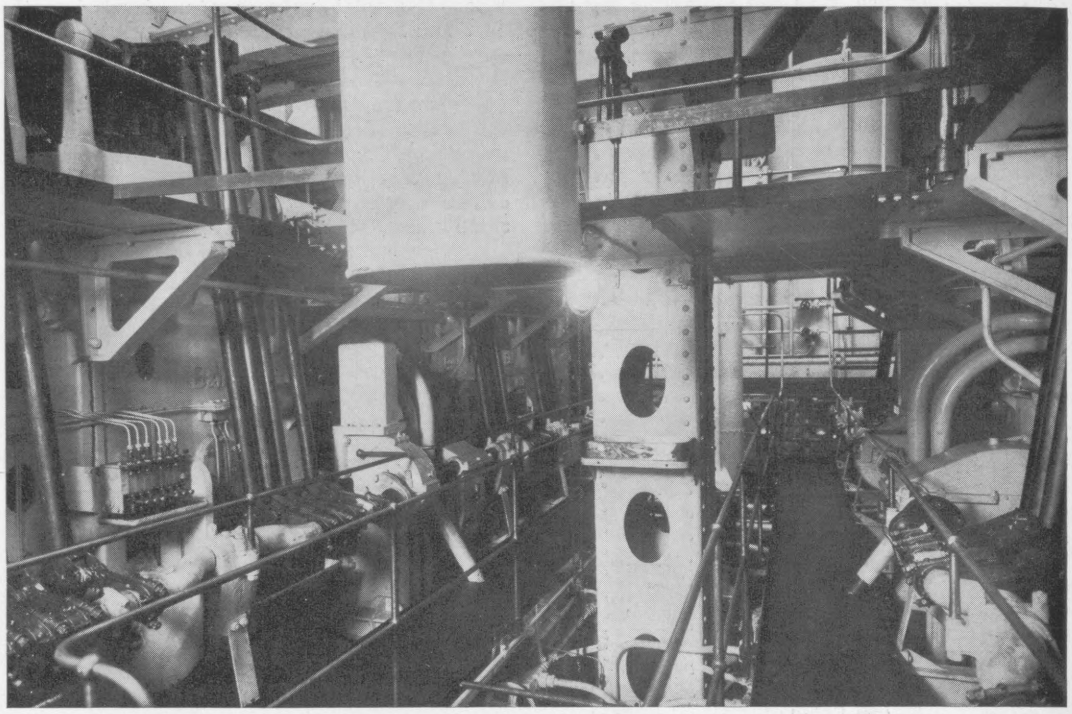


Fig. 155. *View of middle grating of a 4-cycle marine Diesel installation showing push rods on engines*

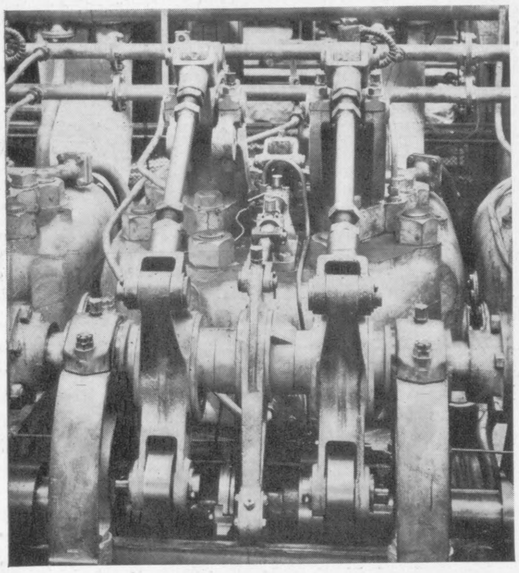


Fig. 154. *Close-up of valve gear*

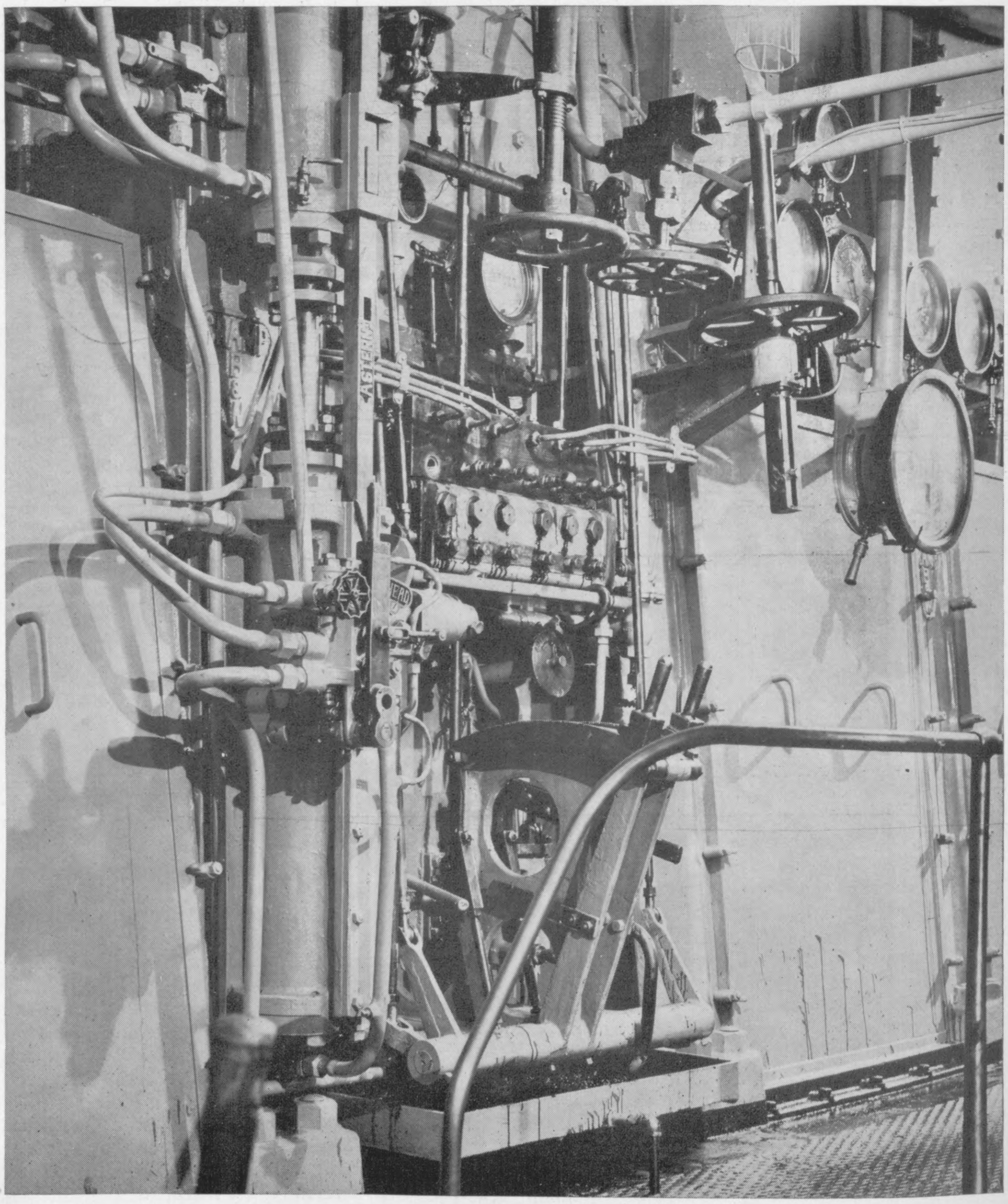


Fig. 156. *Controls at maneuvring station of a 4-cycle marine Diesel engine*

been done either the camshaft or the rollers—depending on the particular system—may be moved sidewise.

The part of Fig. 153 marked *A* shows how rollers of large diameter *t* allow closer spacing *l* of the ahead and astern cams than do smaller rollers *s*. The larger rollers permit the cam noses to pass underneath the roller fork prongs *u*. The smaller rollers make it necessary that the cam noses *v* clear at one side, while the center distance *r* is greater than *l* by the thickness of the cam roller fork prong.

A ready method of withdrawing rollers from the radius of action of the cams was discussed in relation to Fig. 148 in the preceding chapter. Although in that particular instance only the starting and fuel cam rocker levers were eccentrically mounted, it is easy to understand how all the levers may be withdrawn and replaced in the same manner. While in the stop position sketched at the upper left-hand corner of Fig. 148 the camshaft may conveniently be slid endwise and reversal of the engine thus brought about. A further example of this system is illustrated in Fig. 154.

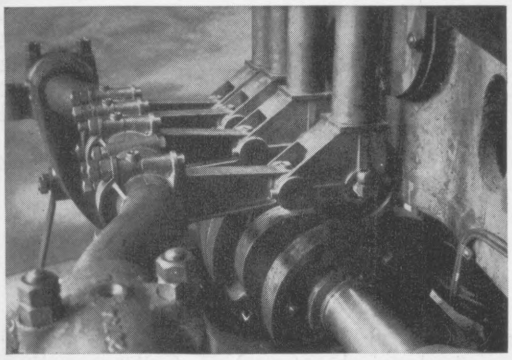


Fig. 157. *Cam rollers in operating position*

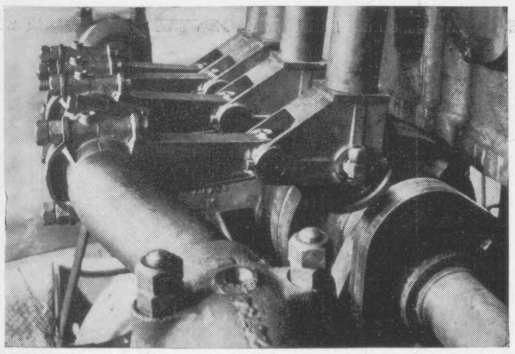


Fig. 158. *Cam rollers in reversing position*

When push-rods are interposed between the end of the valve rocker lever and the cam rollers, as in Fig. 157, it is not necessary to pivot the levers eccentrically, because the rollers may be more conveniently withdrawn by the guide links. These are short levers normally held stationary at one end and fastened to the lower ends of the push-rods, their purpose being to give the cam roller a definite arc of travel relative to the camshaft. That end of the guide link which is normally held stationary is rotated during the reversing period and withdraws the cam rollers while the camshaft is being shifted. In this and allied maneuvering systems the guide-link shaft or its equivalent makes a complete 360 degree turn for each reversal, always bringing the rollers back to their normal working position at the end of its rotation.

The "stationary" ends of the guide links, as a matter of fact, are all pivoted on a long crankshaft having one throw for each brace of guide links belonging to an individual cylinder. All the throws of this long crankshaft stand together on the same centerline, while its bearings are naturally located between the throws in the way of the camshaft bearings. As all the cranks are in the same phase, their rotation always produces simultaneous withdrawal or replacement of all the rollers on each of the cylinders.

To a person watching one of these guide-link crankshafts revolve in the course of a reversing maneuver it appears as though there were no halting of its motion, despite the fact that there are really three distinct phases of it. These are: 1) Clearing the rollers away from the cams, 2) shifting the camshaft and 3) replacing the rollers. A close-up view of the rollers in place is reproduced in Fig. 157. After withdrawal they appear as shown in Fig. 158, where the large cam in the right foreground also appears partially shifted sidewise.

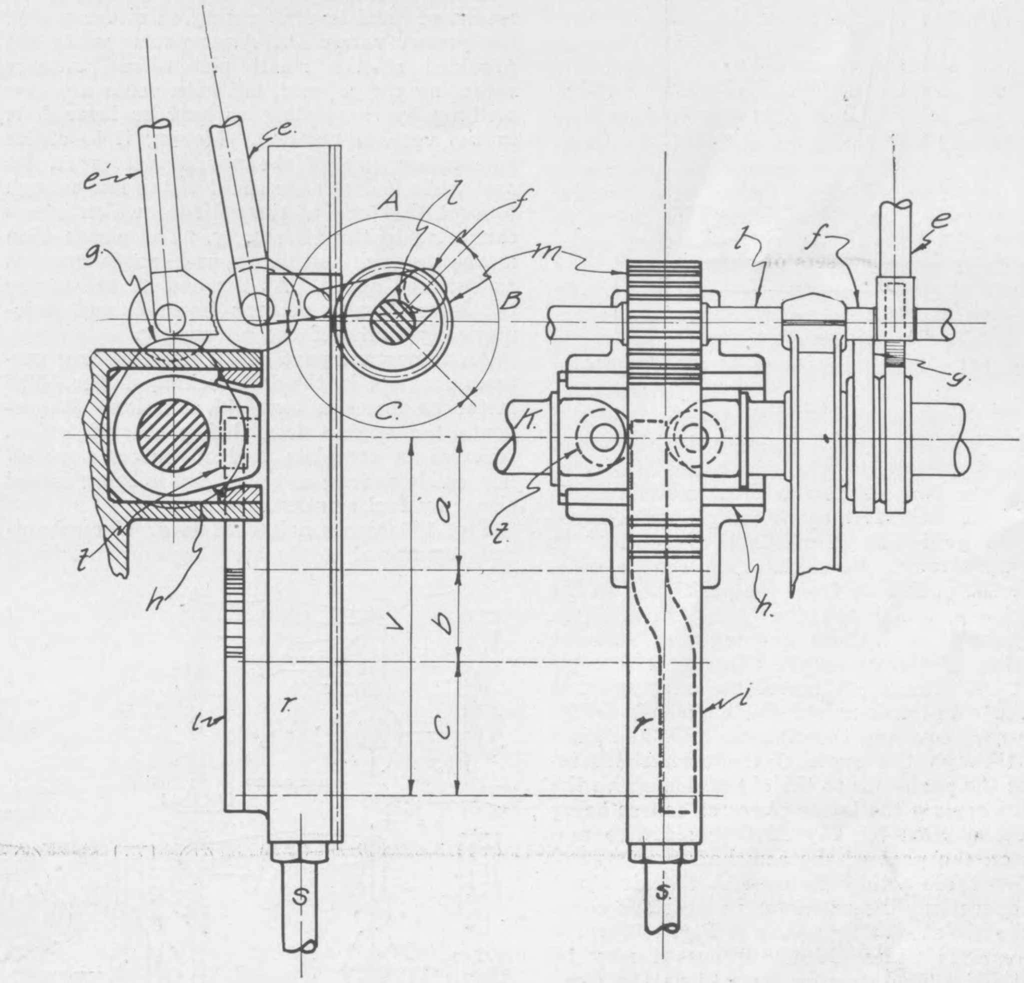


Fig. 159. *Sketch of details of reversing gear mechanism of the engine shown in Fig* 156

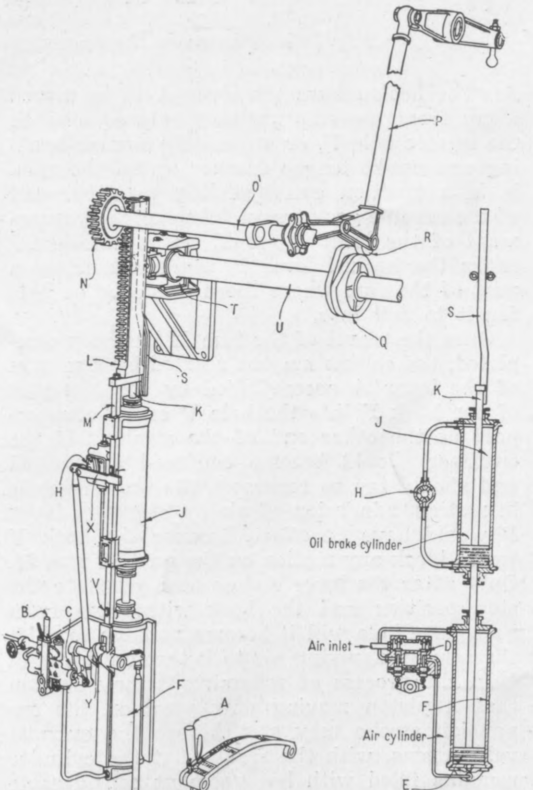


Fig. 160. *View of reversing mechanism*

Naturally the rotation of the guide-link shaft and the shifting of the camshaft must be geared together in such a way as to reduce the operations listed above to a single continuous maneuver capable of simple control by the ship's engineer. It would hardly do for the man answering bells to think about withdrawal, shifting, and replacement as separate matters requiring his attention.

Spinning over the guide link shaft for one revolution as a matter of fact is accomplished by a rack and pinion, the latter being keyed to one of the journals on the guide-link crankshaft. On the back side of the pinion also is a longitudinal cam-track which causes the endwise motion of the camshaft. As the movement of the rack, along with all the gear attached to it, would require far more power than the operating engineer could conveniently produce, an air cylinder, as shown in Fig. 160, is provided for the purpose. It actuates a long piston rod terminating in the rack referred to above the latter being encased in a housing clearly visible in Fig. 156.

A diagrammatic representation of this reversing system is sketched in Fig. 159, where the rack *r*, pinion *m* and longitudinal cam-track *i* are plainly indicated. Surrounding the camshaft *k* in the way of the rack and pinion is a thrust bearing held between two collars turned on the shaft, and is guided by means of crosshead gibs *h* and carries two rollers *t* adapted to convey motion from the cam track as the latter moves up or down.

Let it be assumed that the rack *r* is stand-

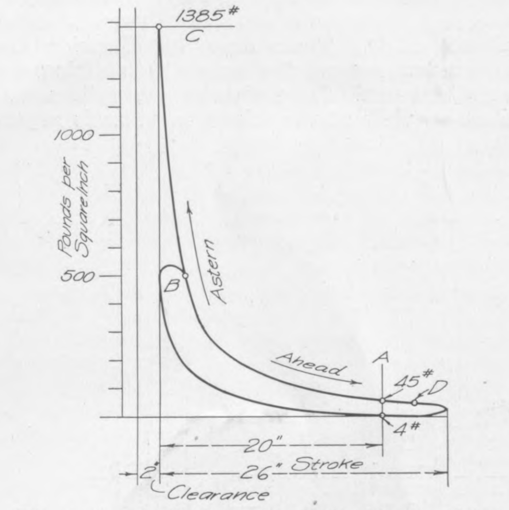


Fig. 161. *Relief valves avoid this condition*

ing in the ahead position as drawn. As it is pushed upward by the piston rod s the upper straight portion of the cam-track slides between the two rollers t without moving them, while the rack teeth cause the pinion m keyed on the guide-link crankshaft to rotate. In moving through the angle A the cranks withdraw the push-rods from the position e' to the position e, the distance a being traversed in the meantime without causing any sidewise shifting of the camshaft. During the angle B of the crankshaft travel the offset portion of the cam-track moves the camshaft to the left while covering the distance b. While passing through the angle C the crankshaft returns the push-rods to the e' position above the astern cams g the latter phase of course being unaccompanied by any further sidewise motion on the part of the camshaft.

How these actions fit in with the air starting operations discussed in the previous chapter may be studied by means of Fig. 160, where the various parts already discussed may be identified. The starting lever A is the same as the one marked a on Fig. 147 of the foregoing chapter. For the sake of clearness the linkage for the master air valve and connection to the fuel pump have been omitted from Fig. 160.

In addition to the air cylinder used to move the rack and pinion as described above, an oil cylinder J (Fig. 160) is fitted in order to prevent the reversing mechanism from moving with excessive speed and striking a hard blow at the end of its travel. The braking action depends upon the resistance to the flow of oil

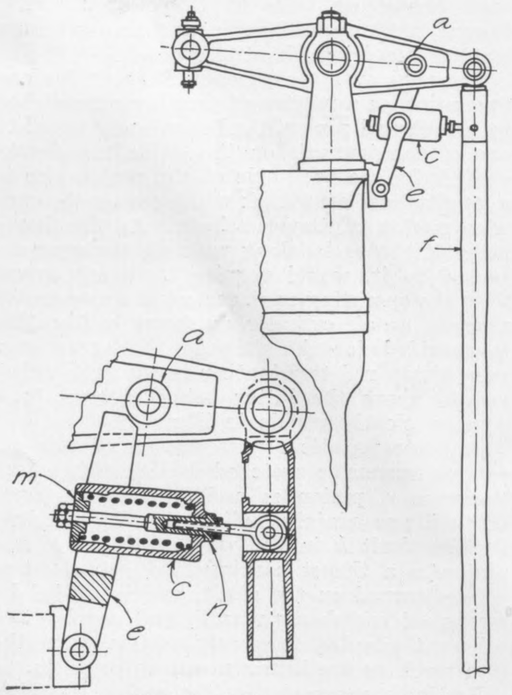


Fig. 162. *Sketch of Compression relief gear*

past the cock H. It is a minimum when the pistons move slowly and increases sharply whenever there is a tendency to speed up. The cock H is automatically shut by means of the lever X when the ram reaches either end of its travel.

Air is admitted to the lower cylinder F by means of hand lever B acting on either one of the poppet valves D. Atmospheric vents are provided at the small piston-like plungers actuating the poppets, but both vents are covered up by the pistons so long as lever B is in the vertical position. Moving it to either side raises one of the poppet valves off its seat while it drops the small piston low enough to vent that end of the cylinder which is not connected to the air supply. The piston then moves the rack and pinion and causes reversal as outlined above. At the end of the stroke the lever X also returns lever B and automatically shuts off the air supply.

An important part of all maneuvering systems consists in the interlocking device. The latter performs a two-fold function: it prevents the engine from being started before reversal is complete and it makes reversal impossible so long as the engine is being moved either by fuel or starting air.

Fig. 160 shows a hooked lever Y mechanically connected to the starting and fuel lever A. The hook allows the lever A to be moved away from the stop position only so long as the square hole V, or an exactly similar opening one stroke length further up on the ram, is in a position corresponding to either end of the reverse gear travel. As sketched, movement of the lever A would be impossible because the hooked lever Y would encounter a part of the ram where there would be no hole for it to fall into.

Once the travel of the ram M has been completed, the engine may be started by a motion of the lever A accompanied by the insertion of the hook Y into the hole V or its counterpart at the other end of the stroke. If the engineer should become confused or excited and should try to reverse while the engine is in motion, admission of air by means of lever B would have no effect, because the hook Y would block any motion on the part of ram M. Only after the lever A has been put into the stop position and the hook withdrawn from its square hole will it become possible to shift the ram by applying air to it through lever B.

In the process of reversing it may happen that a piston moving downward on the expansion stroke may stop before the exhaust valve opens, with the result that the cylinder remains filled with hot gases at considerable pressure. If this cylinder is the next one in order to fire when the engine runs astern, compression will occur in it as the piston travels upward. However, instead of being called upon to compress atmospheric air, the piston will now be resisted by hot gases having an initial pressure many times as great.

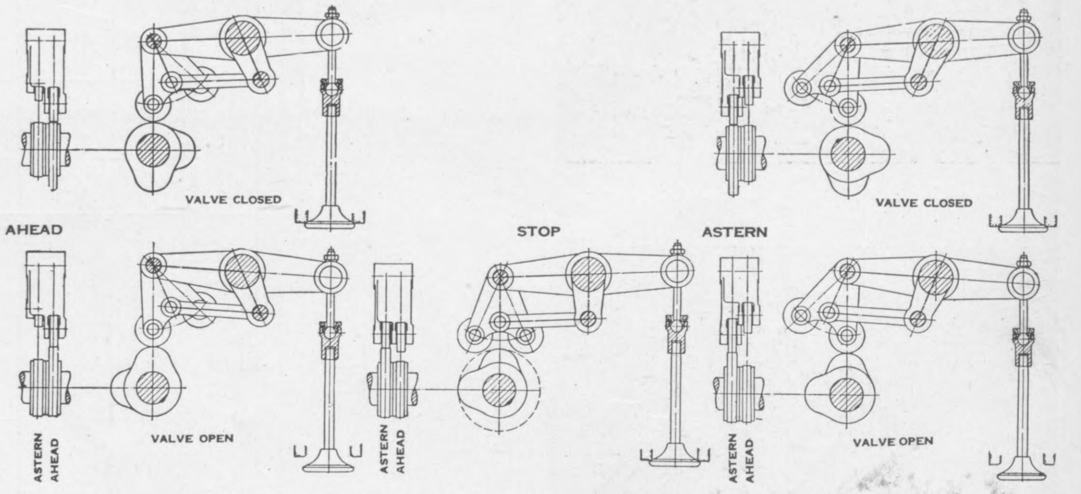


Fig. 163. *Phases in the operation of a dual roller reverse mechanism*

Unless the compression is relieved by some suitable device, the engine will stall, no matter what efforts may be made to move it with starting air admitted to the other cylinders. Lacking a compression relief gear, the engineer may throw the reverse mechanism back again into the same direction as that in which his engine was previously running in the hope that it will then stop without unrelieved expansion in any of the cylinders.

Such a condition is illustrated by means of the indicator card in Fig. 161. Ordinarily, if the fuel is shut off while the ship is under full headway, the drag of the water past the propeller will keep the engine running long enough to insure that several turns are made without ignition occurring in the cylinders. However, a short signal may have been given merely in order to check the motion of the ship slightly and the order to stop may have come before the water has been made to flow actively in the direction which the propeller is attempting to impart to it. In that case a large 4-cycle engine may stop very abruptly, so much so that an expansion in one of the cylinders is effectively resisted by the combined action of compression in an adjacent cylinder and a water wake having a direction such as to resist the propeller.

Let it be assumed, for instance, that the piston stops 6 in. short of the bottom dead-center as indicated at A Fig. 161. It would have had to travel to the point D in order to cause the exhaust valve to open and relieve the pressure. Actually 45 lb. per sq. in. remains in the cylinder. If an attempt then be made to go astern, the piston will meet this pressure instead of the 4 lb. per sq. in. which it would have encountered on a normal compression stroke. In order really to get the piston over the dead center under these circumstances, the hot gases would have to be compressed into the clearance space with a maximum of 1,385 lb. per sq. in. pressure.

These pressures really tell only half the story, because the effective turning moment produced on the crank by the expansion pressures have a much higher peak than the moment due to compression pressures.

On practically all large marine engines of the 4-cycle type compression in the cylinders is automatically relieved whenever the reverse gear goes into action. Obviously it is not necessary to relieve compression when the engine is started up again in the same direction as that in which it previously ran, because then any unfinshed expansion aids, instead of resisting, the starting impulse.

Compression is most commonly relieved by a mechanism which slightly lifts the exhaust valve, although sometimes the spring-loaded safety valve is arranged to be lifted by a gear deriving its motion from the reverse shift. Using the relief valve for this purpose has the advantage of requiring only a light actuat-

(*Continued on page* 544)

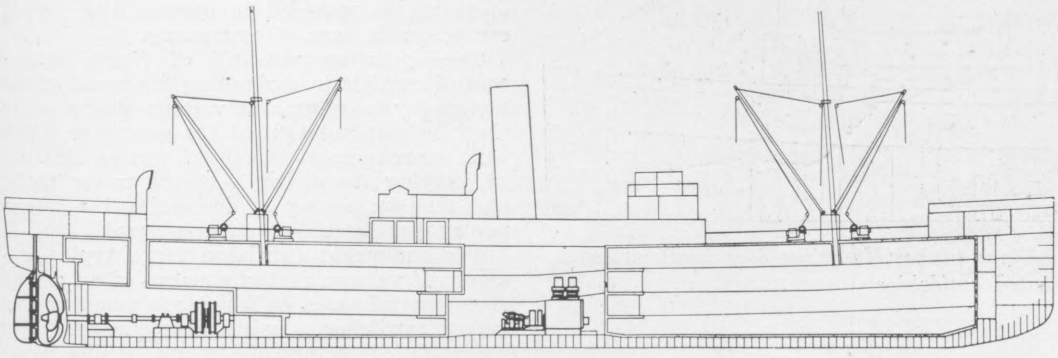
Diesel-Electric System of Propulsion

Shows Undoubted Economy Over Steam Plants and Has Been Brought to a High State of Development

By W. H. Wild*

RAPID increase in the use of Diesel engines as a form of ship propulsion may be largely attributed to two principal factors, first, their undoubted economic superiority over steam and, second, the high stage of development to which they have been brought as a result of efforts to fit them to the requirements of marine service. Even in their present status, however, they are, when used as a direct connected unit, subject to limitations in the case of certain classes of ships. In such cases it is only when the electric motor is inserted as a connecting link between the engine and the propeller that full advantage can be taken of their undoubtedly superior features.

By using the electric motor and its generator



Diesel-electric propulsion gives extra refrigerated space in fruit carriers

as a form of speed reduction agent, it is possible to install a high-speed, light and compact Diesel engine that may be run at its most efficient speed without regard to the speed of the propeller. Furthermore, because of the flexibility of the electric power plant, it is possible to fit it exactly to the requirements of the case in hand.

While Diesel-electric drive is not offered as a universal solution for propulsion problems, owing to the wide variation in circumstances which surround practically every individual application, it does offer possibilities worthy of consideration in every case both by the engine manufacturer and the shipowner. For instance, it gives the former an opportunity to standardize on a form of light, high-speed engine, made up of a comparatively small number of similar parts, easily stocked and interchangeable. To the shipowner it means a compact, efficient power plant, capable of continuous and practically automatic operation under all conditions, subject to easy and exceptionally accurate control and sufficiently flexible to meet practically any reasonable demand for power—and meet it instantly.

In any criticism of the merits of Diesel-electric drive two points are usually stressed as important handicaps: first, the energy loss in the electrical system, amounting to some 12 to 15 per cent, and, second, the high initial cost of the Diesel electric system.

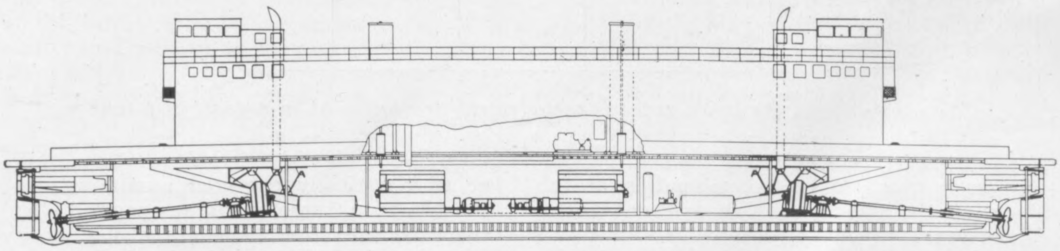
With regard to the first point, although there is a loss in the electrical apparatus in many applications there are several ways in which this is offset, depending on the specific conditions under which the ship operates. The second claim, that of higher initial cost, is also questionable, since so much of its truth depends upon the basis of comparison. While in many instances the electric drive has cost more than direct drive, it is usually such a small percentage in the total cost of the ship as to be practically negligible. Besides, the advantages obtained by the use of electric drive far overbalance the slight increase in cost where properly applied.

The principal advantages of Diesel-electric drive may be summarized as follow:

Sufficient units may be installed to insure continuity of service without sacrificing economy. In other words, a sufficient number of small generating units may be installed to permit the shutting down of some of them, for inspection or overhaul, without seriously affecting the speed of the ship.

A saving in space is effected, owing partly to the small vertical dimensions of the engines, which reduces the amount of head room required, and partly to the fact that the propulsion motor can be located at the most convenient point, without regard to the generating plant, thus eliminating shaft tunnels and other space wasted at the expense of cargo room. An examination of the engine room layouts shown will give an idea of the amount of space that it is possible to save.

Better schedule speeds are possible. This arises from the fact that the propeller is driven at a constant speed or torque by the electric motors, even in a heavy sea, because there is no racing of the propeller. Also, if repairs to the generating or engine equipment become necessary at sea, the ship's speed need not be materially reduced while the repairs are being made, which makes for safety.



Ferryboats have economical operation with maximum maneuvring ability

The maneuvering facilities of the ship are greatly increased. This point is important in all cases, but especially so in the case of small harbor craft such as tugboats and ferry boats. The reasons for the high degree of maneuvering ability are the rapid and positive control over the propulsion motor, the fact that reversals are obtained without affecting either the speed or direction of rotation of the Diesel engines, and the rapid acceleration and retardation possible with the electric motor.

Accurate measurements of the amount of power being delivered to the propeller are obtainable at all times, not only in the engine room but in the pilot house. This not only makes it possible to avoid overloading the generating equipment, both engines and generators, but indicates the existence of such overloads as soon as they begin, and furthermore, serves as a means for the early detection of troubles in the propelling equipment which may quickly become serious.

Complete control can be obtained from the pilot house if desired. This is a decided advantage for vessels operating in crowded waterways.

Owing to the comparatively small size of the Diesel engines, spare parts are easily carried, and repairs can readily be made at sea by the ship's personnel.

The personnel need not be more numerous or more highly trained in electrical matters than that necessary on the up-to-date direct Diesel driven ship, with the usual large complement of electric auxiliaries.

The only auxiliary generating set that is necessary in most cases is a small one for lighting the ship when in port, since the main power plant can usually take care of the power required to operate the auxiliary equipment both at sea and in port. This feature frequently effects a material reduction in capital invested.

In some classes of cargo service the power requirements vary considerably over long periods. With Diesel-electric drive, where a number of small units are installed, only those necessary to supply the actual power demand are operated, the rest being shut down until needed without impairing the overall efficiency of the vessel.

Equipment furnished for use on Diesel-electric vessels consists of the generators, both main and auxiliary, the propulsion motors, and the control for the electrical end of the system, and electrical equipment for auxiliaries. Most ships equipped with Diesel-electric drive up to the present time are using direct current apparatus, and, in view of certain characteristics of direct current, it will probably continue to be preferred to alternating current in the majority of cases. The reasons are simple; direct current permits all speed changes to be accomplished without changing the engine speed, thus necessitating only a simple control system; when several engines are used it is unnecessary to run the generators in parallel or on separate motors as would be required with alternating current machines. The fact that with direct current generators the prevailing method is to connect them in series adds to the simplicity of the system.

The main propulsion generators used for Diesel-electric drive are usually shunt wound, direct-current machines, designed for direct connection to the Diesel engine and especially built for marine service, being moisture and oil proof.

The auxiliary generators are of the same

* Federal and Marine Department, General Electric Co.

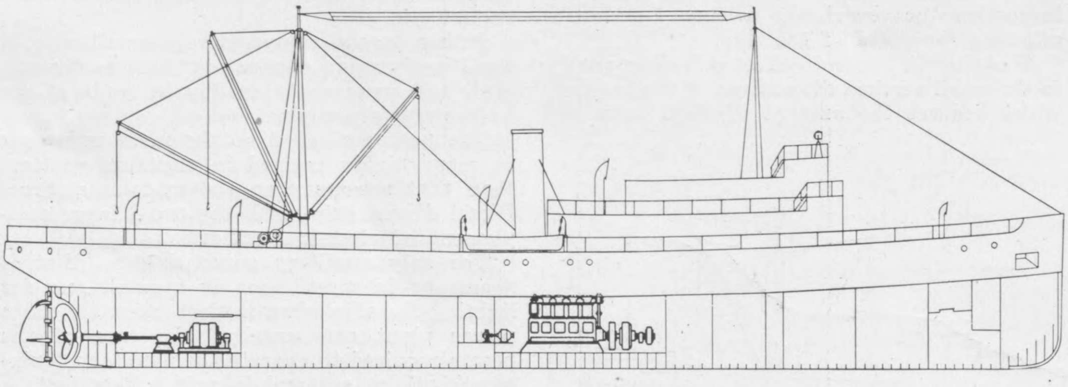
type and construction as the main generators, with the exception of a few details that are modified because of the difference in size and capacity.

The motors used for propulsion are usually shunt wound, direct-current type and are built for direct connection to the propeller shaft. With the exception of some details, they are of the same construction and general type as the main generators. They may, however, for the purpose of description, be divided into two classes; namely, single and double armature motors.

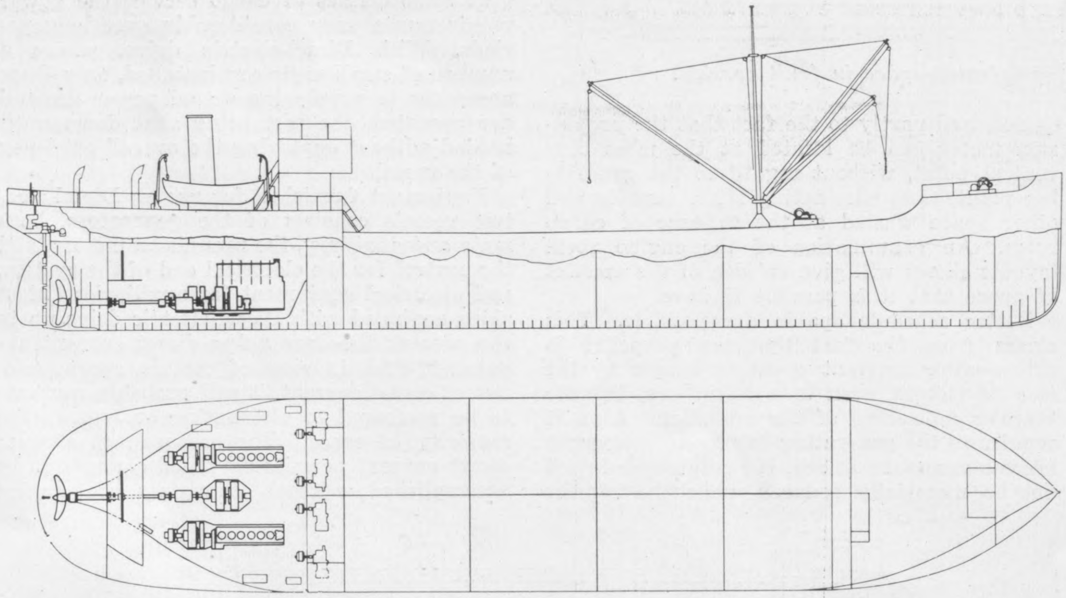
The main points of difference between the two classes are in the bearing arrangements and the method of ventilation. In the single armature motors the bearings are of the ball-seated, self-aligning type, and are split through their horizontal diameter. The bearings are so designed that neither a 25-deg. roll or list nor a 10-deg. pitch will cause oil to run out of them and along the shaft. Ventilation is provided by a combination of fan blades on the armature or an external motor-driven fan.

The double armature motors consist actually of two separate motors mounted on the same base, and having their armatures mounted on the same shaft with the commutators outwards. The shaft is supported by two pedestal bearings bolted to a common foundation. Ventilation of the motors is provided by an external motor-driven fan which forces clean air into the chamber formed between the motors by the sheet steel casing which connects the magnet frames. The air passes between the armatures and the fields, and out over the commutators.

Up to the present two types of control have been developed for use on Diesel-electric vessels. One of these types is known as rheostatic, or armature control, and the other as voltage control, or the Ward-Leonard system. Examples of both types, with modifications, have been applied successfully in different varieties of ships, the choice in each case having been determined by the ability of the control to meet the requirements of that particular ship. The two systems have very marked individual characteristics which exert considerable influence on the question of their suitability in given cases.



Diesel-electric propulsion permitted the special type tanker Hawaiian Standard's main generators to be located amidships



The above shows the more usual Diesel-electric arrangement in a coastwise tanker

The factors that have most to do in determining the proper variety to use in any case may be briefly outlined as follow—Ward-Leonard control is the more flexible of the two. It gives a possible 60 points of speed gradation as against a possible 8 to 12 in the case of rheostatic, and it also permits variation in torque to meet different service contingencies. It does, however, require the use of separate exciters, which are dispensed with in the rheostatic system. Rheostatic control is especially adaptable to ships having a number of electrically operated auxiliaries, particularly when these are to be operated simultaneously with the main propulsion motors. This advantage arises from the fact that the main generators are constantly run at full voltage, hence no extra generators are required to insure a steady and adequate supply of power for the auxiliaries.

Rheostatic control is, however, subject to limitations that practically preclude its use on ships of more than about 1000 hp. or thereabouts. This limitation may be partly ascribed to the fact that speed variation involves breaking the main power circuit and partly to the fact that the different gradations in the propeller speed are obtained by the insertion of resistance in the main circuit. As a consequence, in the first place, as the horsepower increases the necessary contactors become proportionally heavy, bulky and expensive, and the maintenance of proper operation becomes increasingly difficult. Secondly, the size of the resistors necessary becomes unduly great, and large amounts of power are wasted in heat, thereby impairing the efficiency of the whole system.

With Ward-Leonard control on the other hand, the amount of power to be handled has no appreciable effect on the size of the control equipment, and no power is wasted, since only enough is actually generated to take care of the immediate needs of the propulsion motors.

With rheostatic control, speed variation during running periods, and proper acceleration and deceleration during starting and stopping, depends upon the insertion of blocks of resistance in the circuit between the generator and the motor armatures. The control equipment supplied for this purpose consists, essentially, of an engine room control panel, a motor room panel, the motor control groups, the starting resistors, the pilot house master controller; if desired an engine room master controller, and the necessary instruments, knife switches for changing the connections between the motors and generators, and protective equipment. While the operation of this equipment is usually electrical, a system of manual operation is provided to operate the control contactors in case of emergency.

The operating principle of Ward-Leonard control consists in controlling the speed of the motors by varying the voltage delivered to them by manipulation of the generator fields. Further refinement in control can be obtained by varying the strength of the motor fields, and thus increasing or decreasing the torque per ampere for any particular speed.

The equipment furnished for a typical example of voltage control consists of an engine room control panel on which are mounted necessary switches, instruments, motor field rheostats, contactors and relays, a pilot house panel carrying instruments for indicating propeller speed, line amperes, and motor field amperes, a controlling rheostat for varying and reversing the shunt field current of the main generators, and which may be operated from either the pilot house or the engine room, and an exciter control panel, mounted in the engine room. In addition, are the necessary switches for disconnecting the motors and generators, transfer switches and protective devices.

The application of Diesel-electric drive to towboats offers more possibilities in the way of improved operation and economy than to almost any other class of ship. To anyone familiar with these vessels and the work they do, the reasons underlying such a statement are readily apparent; nevertheless, the actual advantages arising from the use of Diesel-electric drive are worthy of some detailed consideration. The principal advantages may be summarized as follow.—

With the Diesel-electric form of drive the engine speed is entirely independent of the propeller speed and hence it is possible to start and stop the propeller as well as provide all propeller speed gradations from zero to maximum in either direction with the engine running at normal rated speed in one direction only.

The above inherent characteristic allows the selection of a propeller designed primarily for towing and makes available full designed engine power at varying speed of the propeller. This latter feature therefore allows the propeller torque to be adjusted to all duty, either accelerating a tow, towing heavy or light loads or running free.

The tow rope pull over the entire towing range is higher than with any other form of drive when measured as a percentage of the engine b.hp. due to the variable speed reduction characteristic of the electric transmission and the higher propulsive efficiency. In addition, the same power plant that provides the energy for propelling the ship can be used for

driving electric auxiliaries such as fire or salvage pumps, and cargo pumps located either on the towboat itself, on other vessels, or on shore.

One of the essential requisites of towboat service is the ability to maneuver rapidly and this requirement is perfectly met in the case of Diesel-electric drive. Thanks to the direct control available in the pilot house, the towboat and its tow can be controlled so as to meet any set of circumstances that may arise. For instance, in taking up the pull on the tow line, or in maneuvering a tow, the pilot of the towboat is able to watch the lines and his ship at the same time, and apply power gradually, and uniformly, as needed. These statements are far from being theoretical, and they are thoroughly borne out by the results of actual tests.

So far the General Electric Company has built the equipment for two sets of towboats, VAN DYKE I, II, and III and two boats being built by the New York Central Railroad Company. The three VAN DYKES are uniform as to dimensions and equipment. They have an overall length of 97 ft., beam of 21 ft., and molded depth of 11 ft. 6 in. The propulsion equipment consists of two 3-cylinder 225 b.hp. Ingersoll-Rand Diesel engines directly connected to two 125 volt, shunt, wound, direct current generators, supplying power to a 370 hp., 250 volt, shunt wound, direct current motor directly connected to the propeller shaft. Excitation is furnished from either of two 26 kw. shunt wound auxiliary generators mounted on the same shaft as the generators. The control is Ward-Leonard, with operating station in the pilot house only.

The New York Central Boats are uniform in electrical equipment. They are 108 feet long, beam 26 feet. The propulsion equipment consists in one boat of two Ingersoll-Rand Diesel engines and in the other of McIntosh & Seymour engines of 400 b.hp. each, directly connected to 270 kw., 240 volt, compound wound, direct current generators which supply power to a 650 hp. 480 volt, double armature, direct current motor directly connected to the propeller shaft. In addition to the two main generators, there are two 30 kw. auxiliary generators, for furnishing excitation, etc., mounted on shaft extension of the main generators. The control is of the Ward-Leonard type, arranged for direct operation from the pilot house.

The application of Diesel-electric drive to two different types of ferryboats (double ended and side wheel) has drawn attention to certain of its possible advantages that are especially valuable in such service. With both types of boat Diesel-electric drive results in a considerable saving in fuel consumption compared with steam, directly traceable to the elimination of standby losses, and to the fact that the increased maneuvering ability available makes docking at the end of trips a much more simple matter than with other drives. This maneuvering ability coupled with the speed of control obtainable is a very valuable characteristic for ferryboats operating in crowded harbors.

Aside from these features, Diesel-electric drive has been the means of solving a troublesome problem that has confronted the operators of double ended ferryboats; namely, the concentration of the installed power on the propeller that is actually driving the ship. Not only is this a simple matter where the propeller motors are independent of the prime mover, as is the case with Diesel-electric drive, but it has been found that by running the bow propeller at a slow rate of speed, it is possible to save an amount of power at least equal to the losses in the electrical system.

With side-wheel ferryboats having one prime mover, by using individual motors for each wheel, either can be controlled, as regards speed and direction of rotation, independently of the other, without regard to the speed or direction of rotation of the prime mover. Since these boats are often maneuvered to some extent by varying the speed and direction of rotation of the paddle wheels with respect to each other, this feature adds grealy to their maneuvering ability. Naturally, the same advantages of economy and accurate maintenance of schedules apply in the case of this particular type of boat.

Double ended ferryboats equipped by the General Electric Company are the GOLDEN GATE, GOLDEN WEST and GOLDEN STATE. The dimensions of the first two are, length 220 ft., breadth 36 ft. 6 in., mean draft 11 ft. 6 in., and gross tonnage 598. The propulsion equipment which is the same for both, consists of two 500 b.hp. Pacific-Werkspoor Diesel engines, each directly connected to a 360 kw., 250 volt shunt wound, direct current generators, supplying power to two 750 hp., 500 volt, shunt wound, direct current motors, one on each propeller shaft. Each of the generators is separately excited from a 35 kw., 115 volt, compound wound, auxiliary generator mounted on the same shaft. Normally the generators are connected in series, supplying power to the motors, which have their armatures connected in parallel.

The control is Ward-Leonard and may be operated from either of the two pilot houses or from the engine room, as desired.

The side wheel boat that has been equipped is a river ferryboat, the FROOMAN M. COOTS. Her dimensions are, length 172 ft., beam 45 ft., depth 7 ft., and tonnage 490. Her propulsion equipment consists of 2 Fairbanks-Morse 240 b.hp. Diesel engines, each connected to 175 kw., 230 volt, compound wound, direct current generators, supplying power to two 175 hp., 230 volt, shunt wound, direct current motors, each connected to one of the two paddle wheels through a system of double reduction gears. This system of double reduction is necessary to obtain the very slow paddle wheel speed of 14 r.p.m.

The control is rheostatic, with one station in the engine room and another in the pilot house. Thus the pilot has complete control of the paddle wheels.

The features of Diesel-electric drive that have most influence on the question of its application to cargo carrying vessels are: reduced fuel expense; maneuvering ability when navigating crowded harbors and when docking; increased cargo space owing to the compact nature of the power plant and the absence of shaft tunnels, and the fact that the necessary auxiliaries, winches, pumps, etc., can be operated from the same source of power as the main propulsion motors, thus eliminating cost and upkeep of auxiliary engine generators. A further advantage is the uniform speed possible due to absence of racing of propeller.

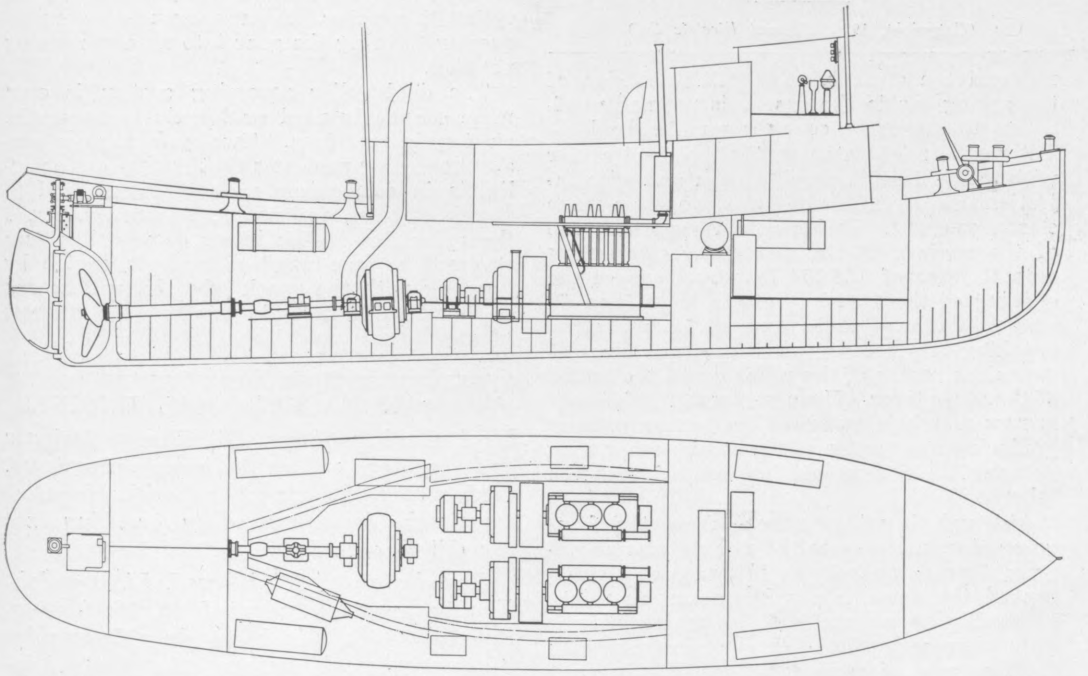
Up to the present, the General Electric Company has equipped cargo vessels of two different classes; FORDONIAN, a Great Lakes vessel, and TWIN PORTS and TWIN CITIES, designed for service between the Great Lakes and New York via the New York State Barge Canal, and for coastwise service along the Atlantic seaboard.

FORDONIAN forms a means of direct comparison between direct Diesel and Diesel-electric drive, being converted from the former to the latter in 1922. It developed on her trial trip that both her speed and her maneuvering ability were greatly increased with the new form of drive.

She is 250 ft. overall, and has a beam of 42 ft., a mean draft of 19 ft., and gross tonnage of 2368 tons. Her propulsion equipment consists of two 350 kw., 250 volt compound wound, direct current generators each driven by a 500 b.hp., 4-cylinder Diesel. The generators are normally connected in series, supplying 500 volts to a double armature, shunt wound, 850 hp., 120 r.p.m., direct current motor, directly connected to the propeller shaft. The control system is combined rheostatic and Ward-Leonard, control being from the engine room. All engine room auxiliaries are electrically driven. A 15 kw., 125 volt, direct current auxiliary generator driven by its own Diesel engine is used to supply power for the auxiliaries when the main engines are shut down.

TWIN PORTS and TWIN CITIES are exactly alike in dimensions and equipment. Their dimensions are, length 252 ft., breadth 46 ft., mean draft 9 ft. 6 in. The electrical equipment consists of 2 Lombard Diesel engines driving two 250 kw., 230 volt, compound wound direct current generators which supply power to 2 separate 250 hp., 180 r.p.m., 230 volt, shunt wound motors each directly connected to a propeller shaft. Control is rheostatic, and is arranged for direct operation from the pilot house, with no intermediate control in the engine room, as is usually the case. The numerous auxiliaries may be operated either from the main propulsion motors, or by a 40 kw., engine-driven, 230 volt auxiliary generator.

The tanker HAWAIIAN STANDARD has her en-



With Diesel-electric drive, towboats can operate their wheels at the most efficient r.p.m. Engine room layout is compact, maneuvring ability 100 per cent

gine and generator room amidships and a separate motor room aft, instead of having her power plant and motors in the same room aft as is the case with the other two. This variation in location of the component parts of the propulsion equipment shows how easily it can be arranged to suit the individual requirements of any case without sacrificing either space or operating efficiency.

Two similar ships with generators aft have a length of 210 ft., breadth of 40 ft., mean draft of 15 ft., and displacement 2725 tons. The propulsion equipment consists of two 400 b.hp. Pacific-Werkspoor Diesel engines each direct connected to a 245 kw., 250 volt, differentially compound wound generator supplying power to a 500 volt 600 hp. double armature shunt wound direct current motor, directly connected to the propeller shaft. There are also two 30 kw., 115 volt exciters, directly connected to the generators, and an auxiliary generator for lighting.

Control is Ward-Leonard so arranged that speed control and reversal is obtainable from either the pilot house or the engine room. It is also possible to operate the cargo pump motors from the main propulsion generators.

One of the latest applications of Diesel-electric drive is its use in furnishing power to self-propelled dredges, and one of the principal advantages of the drive in this connection is that, since the motors operating the dredge pumps can be supplied with power from the main propulsion generators, when the dredge is not under way, the stand-by losses are reduced to a minimum. Of course, other features of Diesel electric drive, as to fuel economy, maneuvering, etc., apply.

General Electric Company has furnished the electrical equipment for the twin screw dredge SANDMASTER operating on the Lakes. She has a length of 261 ft., 43 ft. beam, and her load draft is 18 ft. Propulsion equipment consists of 2 Worthington 600 hp. Diesel engines directly connected to two 400 kw., 230 volt, compound wound, direct current generators, each furnishing power to a 500 hp., 230 volt, direct current motor, directly connected to its individual propeller shaft. One auxiliary generator furnishes excitation for the motors and generators, and another for engine room auxiliary apparatus, steering gear and lighting.

The main pumping apparatus is also driven from the propulsion generators. There are also a large number of additional auxiliary pumps, windlasses, etc., which are driven from the same source. The control is Ward-Leonard, with stations in both the pilot house and engine room, and providing independent control of each propelling motor.

Sketches and Working of Oil Engines

(*Continued from page* 536)

ing gear because the area of the relief valve is small compared with that of the exhaust valve. However, the provisions necessary for using the exhaust valve as a compression relief are so simple and easy to apply that they seem to predominate, compression reliefs fitted to safety valves being comparatively rare.

Somewhere in the mechanical train used to operate the exhaust valve for compression relieving purposes there must be a spring or other yielding member because it may be

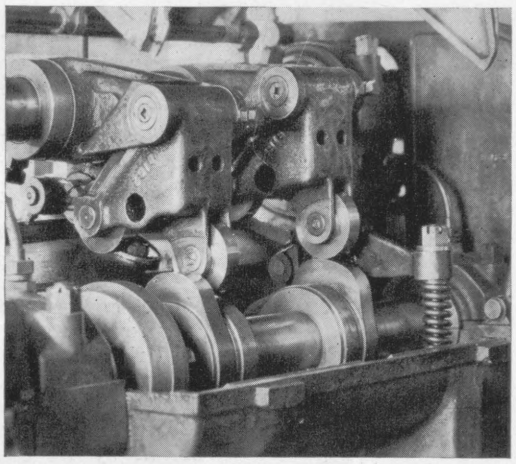


Fig. 164. *Non-shifting camshaft reverse*

thrown into action when pressures of many hundreds of pounds per square inch are holding the exhaust valve against its seat. Several tons of force may then be necessary to thrust it open and an absolutely rigid compression relief gear might be broken in the attempt.

One of the most common forms of compression reliefs is sketched in Fig. 162. Whenever the push-rods *f* are swung outwards in order to clear the cam noses for reversal, they pull the struts *e* through the connection *c*. As the end of the strut *e* is wedged under the auxiliary rollers *a* pinned to the sides of the exhaust valve levers, they lift the exhaust valves slightly and permit any gases to escape from the cylinders. Ordinarily the connection *c* remains rigid and of unchangeable length, serving merely as a tension link between the push-rod and the strut *e*. The initial tension of the spring inside the case *c* is normally sufficient to make the collar *n* remain fixed.

A piston might stop on the top dead center with the fuel valve cracked open and with injection air at 1000 lb. pressure filling the clearance space. If this should happen on one of the engines of the motorliner GRIPSHOLM a total force of 128,000 lb. would oppose the opening of the 12¾-in. valve. More than 60 tons would have to be exerted by the strut *e*, taking into account the short lever-arm between the center of the roller *a* and the center of the valve lever. Upon reversal, the follower *m* now merely compresses the spring without producing any motion of the strut *e* other than bringing its sloping end into contact with the roller *a*.

Although it might appear from the foregoing that the reversal of 4-cycle marine engines depends entirely on side-wise cam shifting of the cams, the substitution may just as readily be accomplished by maintaining a fixed endwise position for the camshaft with the two sets of cams keyed on it. In such systems the cam roller is shifted, being withdrawn from the ahead cams and replaced on the astern cams or vice versa.

As a direct lateral shift would of course make some of the rollers foul the cams, a certain amount of indirection must be resorted to. Sometimes the cam roller is shifted endwise after the valve levers have been lifted by means of an eccentric fulcrum as described in connection with Fig. 150. The forked end of the lever holding the roller has a wide gap equal to the roller thickness plus the center distance between the ahead and the astern cams, a light shaft with guide-fingers for the rollers being shifted endwise while the valve levers have been lifted clear. As far as is known, this system is used by only one maker and as there is little prospect of its being applied on any considerably greater scale than heretofore, it may be safely passed over in a study which must be limited to representative examples.

A commoner method of reversing by means of the non-shifting camshaft is illustrated diagramatically in Fig. 163 and photographically in Fig. 164. It depends fundamentally on using a thrust member to move the end of the valve rocker lever, and on placing dual rollers in the end of the thrust member. The latter is also provided with the usual guide-link similar to that used for ordinary push-rods. Each of the two rollers has its centerline above either the ahead or the astern cams and they are also separated in a direction at right angles to the camshaft far enough to place both rollers beyond the reach of the cams when the gear is in mid-position. An inspection of Fig. 163 will make the arrangement readily intelligible. The reversing operation is there boiled down simply to a matter of swinging through a certain angle all the guide-links keyed to a common shaft.

It will be noted in the central diagram of Fig. 163 that a neutral position, already referred to, is provided in the travel of the twin rollers. The system could of course still be made to work,—that is, clearance for the idle rollers could be provided—if the angle of swing were only half as great. In that case, however, there would never be a position where all the rollers would be off the cams and during the process of reversal it would sometimes become necessary to open some valves against heavy cylinder pressures in the mere act of shifting the reverse.

Compression relief, as a matter of fact, is provided by the "camel's hump" visible in Fig. 164. As the roller member is traversed through the mid-position, it rides up on the bridge supported by the coiled spring. This slightly lifts the exhaust valve and vents the cylinder, making it an easy matter subsequently to bring the gear into normal running position.

The dual roller reversing system is even more commonly used on 2-cycle engines than on 4-cycle machines. Two-cycle engines present reversing problems that appear quite negligible in comparison with those involved in 4-cycle engines, and no one who has mastered the principles of the latter or who has ever reversed a "one-lung" motor-boat engine by juggling with the spark advance, will be apt to find trouble in understanding the reversal of any 2-cycle machine.